State of California

California Natural Resources Agency

Department of Water Resources

CALFED Surface Storage Investigations

Progress Report

November 2010

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Contents

Chapter 1 Introduction 1-1
Background 1-1
Purpose and Scope of Report 1-5
Report Organization 1-7

Chapter 2 Water Management Issues and Challenges 2-1
Declining Ecosystems 2-1
Sacramento-San Joaquin Delta 2-2
Sacramento / San Joaquin River Systems 2-3
Drought Impacts and Water Supply Reliability 2-4
Impaired Water Bodies 2-7
Climate Change 2-8
Increasing Flood Risk 2-9
Population Growth 2-10
Uncertainties of Delta Water Management 2-11
Water Management Issues and Challenges and the CALFED Surface Storage Investigations 2-11

Chapter 3 North-of-the-Delta Offstream Storage Investigation 3-1
Study Areas 3-1
Project Objectives 3-4
Water Supply and Water Supply Reliability 3-4
Survival of Anadromous Fish and Other Aquatic Species 3-4
Delta Water Quality 3-5
Opportunities 3-5
Planning Objectives 3-5
Project Formulation and Initial Alternatives 3-6
Example Sites Reservoir Project Formulation Features and Costs 3-8
Example Sites Reservoir Project Formulation Project Features 3-8
Example Sites Reservoir Project Formulation Project Costs 3-10
Example Sites Reservoir Project Formulation Operations 3-10
Example Sites Reservoir Project Formulation Benefits 3-13

Public Benefits 3-14
Water Supply Reliability Benefits.. 3-18
M&I Water Quality Benefits 3-18
Hydropower/Flexible Generation... 3-19
Example Sites Reservoir Project Formulation Benefits Under an Uncertain Future............ 3-19
Potential Effect of New Delta Conveyance on Project Benefits..................................... 3-19
Potential Effect of Climate Change on Project Benefits 3-22
Sites Reservoir Potential Environmental Effects... 3-22

Chapter 4 Upper San Joaquin River Basin Storage Investigation 4-1
Study Area 4-1
Project Objectives 4-1
Water Supply Reliability 4-1
San Joaquin River Ecosystem.. 4-4
Opportunities.. 4-4
Planning Objectives.. 4-4
Project Formulation and Initial Alternatives 4-4
Example Temperance Flat RM 274 Reservoir Project Formulation Features and Costs........ 4-6
Example Temperance Flat RM 274 Reservoir Project Formulation Project Features........ 4-6
Example Temperance Flat RM 274 Reservoir Project Formulation Potential Project Costs 4-8
Example Temperance Flat RM 274 Reservoir Project Formulation Operations.................... 4-8
Example Temperance Flat RM 274 Reservoir Project Formulation Benefits...................... 4-12
Public Benefits 4-14
Water Supply Reliability Benefits.. 4-15
M&I Water Quality Benefits 4-15
Hydropower/Flexible Generation... 4-16
Example Temperance Flat RM 274 Reservoir Project Formulation Benefits Under an Uncertain Future 4-16
Potential Effect of New Delta Conveyance on Project Benefits..................................... 4-16
Potential Effect of Climate Change on Project Benefits 4-19
Temperance Flat RM 274 Reservoir Potential Environmental Effects................................ 4-19

Chapter 5 Los Vaqueros Expansion Investigation.. 5-1
Project Location 5-2
Project Objectives 5-2

Existing Reservoir ... 5-2
Expanded Reservoir ... 5-4
Project Formulation and Alternatives ... 5-6
Example 275 TAF Los Vaqueros Reservoir Expansion Project Features and Costs ... 5-7
Example 275 TAF Los Vaqueros Reservoir Expansion Project Operations ... 5-9
Example 275 TAF Los Vaqueros Reservoir Expansion Project Benefits ... 5-10
Public Benefits ... 5-11
Water Supply Reliability Benefits ... 5-13
Example 275 TAF Los Vaqueros Reservoir Expansion Project Benefits under an Uncertain Future ... 5-14
Potential Effect of New Delta Conveyance on Project Benefits ... 5-14
Potential Effect of Climate Change on Project Benefits ... 5-16
Los Vaqueros Reservoir Expansion Project Environmental Effects ... 5-17
Construction ... 5-17
Facility Siting/Footprint ... 5-17
Climate Change ... 5-18

Chapter 6 Shasta Lake Water Resources Investigation ... 6-1
Study Area and Project Location ... 6-1
Project Objectives ... 6-2
Anadromous Fish Survival ... 6-2
Water Supply Reliability ... 6-4
Opportunities ... 6-4
Planning Objectives ... 6-4
Project Formulation and Initial Alternatives ... 6-4
Example 18.5-Foot Shasta Dam Raise Project Formulation Project Features and Costs ... 6-6
Example 18.5-Foot Shasta Dam Raise Project Formulation Project Features ... 6-6
Example 18.5-Foot Shasta Dam Raise Project Formulation Project Costs ... 6-9
Example 18.5-Foot Shasta Dam Raise Project Formulation Operations ... 6-9
Example 18.5-Foot Shasta Dam Raise Project Formulation Benefits ... 6-10
Public Benefits ... 6-10
Water Supply Reliability Benefits ... 6-13
Hydropower Generation ... 6-13
Example 18.5-Foot Shasta Dam Raise Project Formulation Benefits Under an Uncertain Future ... 6-14

Potential Effect of New Delta Conveyance on Project Benefits 6-14
Potential Effect of Climate Change on Project Benefits 6-15
Shasta Reservoir Enlargement Potential Environmental Effects 6-16

Chapter 7 Summary and Next Steps 7-1
Summary 7-1
Next Steps 7-4
Senate Bill 2 and Funding to Develop Storage 7-4

Chapter 8 References 8-1

Appendices A through D ...... back of report

Boxes

Box 1-1. Chapter 1 Acronym and Abbreviation List.....1-2
Box 2-1. Chapter 2 Acronym and Abbreviation List.....2-2
Box 3-1. Chapter 3 Acronym and Abbreviation List.....3-2
Box 4-1. Chapter 4 Acronym and Abbreviation List.....4-2
Box 5-1. Why Los Vaqueros Reservoir is an Ideal Site for Expanded Storage:.....5-1
Box 5-2. Chapter 5 Acronym and Abbreviation List.....5-1
Box 5-3. CCWD Board of Director's Resolution No. 03-24.....5-5
Box 5-4. Reports Related to the Los Vaqueros Expansion Investigation.....5-6
Box 6-1. Chapter 6 Acronym and Abbreviation List.....6-2
Box 7-1. Chapter 7 Acronym and Abbreviation List.....7-2

Figures

Figure 1-1. Location of Potential Surface Storage Projects.....1-3
Figure 1-2. Potential Configurations of New Delta Conveyance.....1-6
Figure 2-1. Fish Trends Depicting Delta Pelagic Organism Decline, 1967-2005.....2-3
Figure 2-2. The Delta and Sacramento and San Joaquin Rivers.....2-5
Figure 2-3. Decreasing California Snowpack.....2-9
Figure 3-1. NODOS Investigation Primary Study Area.....3-3
Figure 3-2. Sites Reservoir Project Location.....3-7
Figure 3-3. Sites Reservoir Inundation Area and Project Features.....3-9
Figure 3-4. Summary of Potential Benefits of the Example Sites Reservoir Project.....3-15
Figure 4-1. USJRBSI Primary Study Area.....4-3
Figure 4-2. Temperance Flat RM 274 Reservoir Project Location.....4-7
Figure 4-3. Temperance Flat RM 274 Reservoir Inundation Area and Major Project Features.....4-9
Figure 4-4. Integrated Operations of South-of-Delta Facilities.....4-11
Figure 4-5. Summary of Potential Benefits of the Example Temperance Flat RM 274 Project.....4-13
Figure 5-1. Los Vaqueros Reservoir Project Location.....5-3
Figure 5-2. Location of Los Vaqueros Reservoir Relative to the Delta.....5-4
Figure 5-3. 275 TAF Los Vaqueros Reservoir Expansion Project Inundation Area and Project Features.....5-8
Figure 5-4. Representation of How the Multiple Components of the Los Vaqueros Expansion Investigation Combine to Achieve Project Benefits.....5-10
Figure 5-5. Summary of Potential Benefits of the Example 275 TAF Los Vaqueros Reservoir Expansion Project.....5-12
Figure 6-1. Location of Shasta Dam and Lake and SLWRI Primary Study Area.....6-3
Figure 6-2. 18.5-foot Shasta Dam Raise Project Features.....6-8
Figure 6-3. Summary of Potential Benefits of the Example 18.5-foot Shasta Dam Raise Project.....6-11
Figure 7-1. Potential Long-Term Average and Driest Periods Average Water Supply Yield from the CALFED Surface Storage Projects when Operated with and without Assumed New Delta Conveyance.....7-2
Figure 7-2. Approximate Schedule for the Surface Storage Feasibility Studies.....7-5
Figure 7-3. Bond Fund Breakdown.....7-6

Tables

Table 3-1. Summary of the Example Sites Reservoir Project Features.....3-11
Table 3-2. Summary of Potential Benefits (Yield) of the Example Sites Reservoir Project Formulation.....3-13
Table 3-3. Physical and Statistical Measures of Ecosystem Restoration Benefits of the Example Sites Reservoir Project Formulation.....3-16
Table 3-4. Volumes of Water Associated with Ecosystem Restoration Actions of the Example Sites Reservoir Project Formulation.....3-17
Table 3-5. Potential Reductions in TDS at Banks Pumping Plant Due to the Example Sites Reservoir Project Formulation.....3-19

Table 3-6. Summary of Potential Benefits (Yield) of the Example Sites Reservoir Project Formulation with New Delta Conveyance 3-20
Table 3-7. Physical and Statistical Measures of Ecosystem Restoration Benefits of the Example Sites Reservoir Project Formulation with New Delta Conveyance 3-21
Table 3-8. Volumes of Water Associated with Ecosystem Restoration Actions of the Example Sites Reservoir Project Formulation with New Delta Conveyance 3-21
Table 3-9. Potential Reductions in TDS at Banks Pumping Plant Due to the Example Sites Reservoir Project Formulation with New Delta Conveyance 3-22
Table 4-1. Summary of the Example Temperance Flat RM 274 Reservoir Project Features 4-10
Table 5-1. Summary of Potential Benefits for the Example 275 TAF Los Vaqueros Reservoir Expansion Project Formulation 5-11
Table 5-2. Summary of Potential Benefits for the Example 275 TAF Los Vaqueros Reservoir Expansion Project Formulation with New Delta Conveyance 5-15
Table 6-1. Summary of the Example 18.5-foot Shasta Dam Raise Project Features 6-7
Table 6-2. Potential Anadromous Fish and Ecosystem Restoration Benefits of the Example 18.5-foot Shasta Dam Raise Project Formulation 6-12
Table 6-3. Potential Anadromous Fish and Ecosystem Restoration Benefits of the Example 18.5-foot Shasta Dam Raise Project Formulation with New Delta Conveyance 6-15

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Chapter 1 Introduction

The management of California's water resources has reached a critical point and the challenges to water management are great and varied. This report provides information on how active surface storage investigations are evaluating alternatives to address regional and statewide challenges related to water supply reliability, declining ecosystems, water quality, flood protection, hydropower generation, and recreation opportunities. Further, this report discusses uncertainties related to climate change and water management in the Sacramento-San Joaquin Delta (Delta) (See Box 1-1 for a list of acronyms and abbreviations used in this section) and how these uncertainties impact the surface storage investigations.

Background

The California Water Plan Update 2009 states that "California is facing one of the most significant water crises in its history" and it is "imperative to act." Drought impacts have been intensified by reduced water supplies and a growing population. The current drought is similar to that experienced in 1977, but the current population is 75 percent greater. Fish populations, ecosystems, and water quality continue to decline, particularly in the Delta and its tributaries. Water deliveries from the Delta have been reduced due to court decisions and new regulations designed to protect critical species and habitat. Climate change is altering precipitation patterns, reducing snowpack, causing sea level rise, and increasing the potential for both long drought periods and floods (i.e., more variable precipitation). The existing water management system needs to be reevaluated in light of climate change, as the assumptions used to design and operate our current system of reservoirs, channels, aqueducts, and other water management facilities may no longer be valid since it was designed using historical hydrology as an indicator of future conditions. The current system is aging—the State Water Project is more than 35 years old and the federal Central Valley Project is more than 50 years old—and upgrades have not kept pace with changing conditions. (DWR, 2009a)

Our existing water resources infrastructure is already strained to meet competing demands and existing objectives for multiple uses, including water supply, environmental protection, water quality, flood protection, hydropower, navigation and recreation. The strains on the system will only increase with a changing climate and the conflicts between competing interests will be even greater as supplies become less reliable and ecosystems are further strained. The Delta Vision Blue Ribbon Task Force and the CALFED Bay-Delta Program (CALFED) both recognized the value and need for additional storage in the context of our strained water system. The California Water Plan Update 2009 draws a similar conclusion. In a listing of objectives and actions, the plan describes a need to, "advance and expand conjunctive management of multiple water supply sources with existing and new surface water and groundwater storage to prepare for future droughts, floods, and climate change." Further, new state water legislation was enacted in 2009 (See Appendix A. 2009 Comprehensive Water Package) that includes a bond measure that would provide up to $3 billion for public benefits associated with potential storage projects, if the measure is approved by voters. Public benefits paid for by the bond would include ecosystem restoration, flood control, water quality, emergency response, and recreation. According to the bond proposal, water supply reliability benefits for urban or agricultural users would be paid for by those beneficiaries.

Box 1-1. Chapter 1 Acronym and Abbreviation List

BDCP	Bay-Delta Conservation Plan
BO	Biological Opinion
CALFED	CALFED Bay-Delta Program
CCWD	Contra Costa Water District
CEQA	California Environmental Quality Act
Delta	Sacramento-San Joaquin Delta
DHCCP	Delta Habitat Conservation and Conveyance Program
DWR	Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
IAIR	Initial Alternatives Information Report
LVE	Los Vaqueros Expansion
NEPA	National Environmental Policy Act
NODOS	North-of-the-Delta Offstream Storage
PFR	Plan Formulation Report
Reclamation	United States Bureau of Reclamation
SLWRI	Shasta Lake Water Resources Investigation
USJRBSI	Upper San Joaquin River Basin Storage Investigation
WRC	Water Resources Council

Through the CALFED Surface Storage Program, CALFED agencies evaluated 52 potential surface storage reservoir sites. CALFED agencies specifically looked for potential projects that could provide broad benefits for water supply, flood control (i.e., flood protection), water quality, and ecosystem restoration. An interagency team drawn from the CALFED participating agencies eliminated 40 of the potential surface storage sites during an initial screening (CALFED, 2000a). Of the 12 potential surface storage sites identified in the CALFED Final Programmatic Environmental Impact Statement (EIS)/Environmental Impact Report (EIR), five surface storage sites were included in the CALFED Record of Decision for further study and consideration: Sites Reservoir, additional storage in the upper San Joaquin River watershed, expansion of Los Vaqueros Reservoir, expansion of Shasta Lake, and In-Delta storage project. As state and federal legislation was enacted and appropriations were provided, these studies became recognized as the: North-of-the-Delta Offstream Storage (NODOS) Investigation, Upper San Joaquin River Basin Storage Investigation (USJRBSI), Los Vaqueros Expansion (LVE) Investigation, Shasta Lake Water Resources Investigation (SLWRI), and In-Delta Storage Program. State participation in the In-Delta Storage Program was suspended in July 2006 when state funding was terminated (See Appendix B. Summary of the In-Delta Storage Program).

Active CALFED surface storage investigations are evaluating potential projects' abilities to meet needs related to droughts, floods, emergencies, and climate change, and improvements to water quality and aquatic and riparian ecosystems, hydropower generation, and recreation. The investigations are also evaluating how potential new surface water storage projects can supplement the storage capacity and add more flexibility to the state's strained water system, and contribute to the California Water Plan's goal for long-term, sustainable water resources use that enhances our environment, our economy, and our communities (See Appendix C. California Water Plan – Integrated Water Management Framework). The Department of Water Resources (DWR), the US Department of the Interior Bureau of Reclamation (Reclamation), and other CALFED agencies continue to participate in these feasibility study investigations (See Figure 1-1):

- **NODOS Investigation –** DWR and Reclamation are working in partnership with local, regional, state, and federal agencies, and stakeholders to formulate offstream surface storage opportunities in the Sacramento Valley.
- **USJRBSI –** Reclamation and DWR are working in partnership with local, regional, state, and federal agencies, and stakeholders to formulate and evaluate alternatives to develop water supplies in the upper San Joaquin River watershed for multiple purposes.
- **LVE Investigation –** DWR, Reclamation, and the Contra Costa Water District (CCWD) are collaborating with local, state, and federal agencies and stakeholders on the formulation and development of Los Vaqueros enlargement opportunities.
- **SLWRI –** Reclamation is leading the investigation for potential raises of Shasta Dam to enlarge Shasta Lake in consultation with DWR[1], concerned agencies, and stakeholders to evaluate opportunities to improve water supply and reliability for environmental, agricultural, and urban uses.

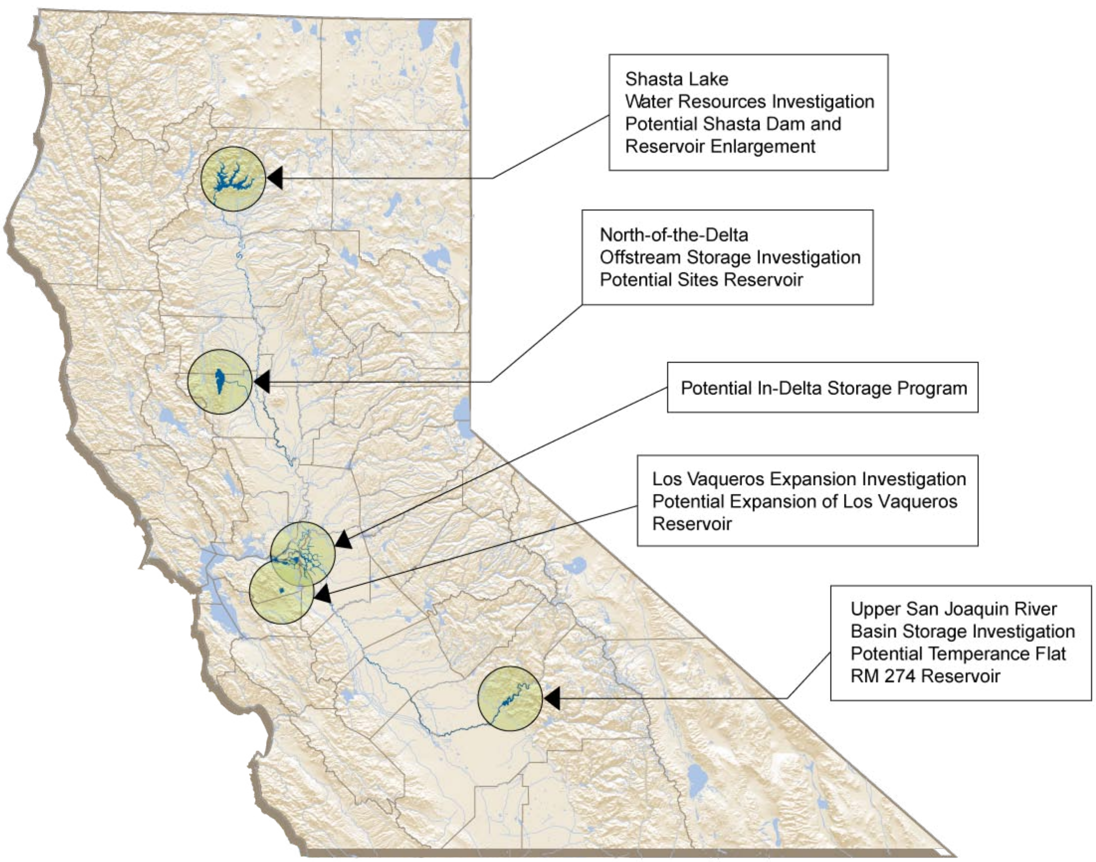

Figure 1-1. Location of Potential Surface Storage Projects

[1] State law, California Public Resources Code 5093.542(c), restricts state involvement in the Shasta Lake Water Resources Investigation feasibility study.

Study management teams for the investigations are jointly following an iterative planning process consistent with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC, 1983). The guidance lays out a study process that first defines problems, needs, and opportunities to support the development of planning objectives and constraints. Then potential solutions are formulated into alternatives by defining management measures and combining them to develop initial alternative plans. The results of the initial phases of each surface storage investigation are documented in project-specific planning reports, such as Initial Alternatives Information Reports (IAIR) and Plan Formulation Reports (PFR). The initial alternative plans ultimately will be refined, evaluated, and documented in the Feasibility Reports and National Environmental Policy Act (NEPA) / California Environmental Quality Act (CEQA) environmental documents to support decision-making by responsible federal, state, and local entities.

The most recent documents for the storage investigations are:

- NODOS Plan Formulation Report, September 2008
- USJRBSI Plan Formulation Report, October 2008
- SLWRI Plan Formulation Report, December 2007
- LVE Draft Environmental Impact Statement/Environmental Impact Report, February 2009
- LVE Final Environmental Impact Statement/Environmental Impact Report for a 60,000 acre-foot enlargement of Los Vaqueros Reservoir, March 2010

Since the release of these interim planning documents, water management, biological, political, hydrologic, and regulatory conditions have changed substantially in the Delta. Such new conditions include 2008/2009 Biological Opinions (BO) for Delta smelt and salmon, Delta pumping constraints, the 2009 Comprehensive Water Package, Bay-Delta Conservation Plan (BDCP) and Delta Habitat Conservation and Conveyance Program (DHCCP) planning and decisions, climate change impacts and adaptation strategies, and sea level rise estimates. There are substantially greater water management challenges in California now than when these feasibility studies were initiated. These challenges and stressors, which are discussed further in Chapter 2, are being considered and incorporated into the surface storage investigations. Additionally, the 2009 Comprehensive Water Package will affect the feasibility studies and the implementation of potential surface storage projects in several ways, such as new planning and coordination for the Delta (e.g., the Delta Plan); the development of flow criteria for the Delta, targets for water use efficiency, and guidelines for determining the economic benefits of projects; and a bond measure that would include funding for public benefits associated with potential storage projects.

These changing conditions, assumptions, Delta planning efforts, and emerging legislation and initiatives have affected the scopes and timelines for the surface storage investigations. For example, analysis conducted for this report includes operations assumptions based on the recent BOs on salmon and Delta smelt (although final systems operations are still being worked out), whereas the analysis contained in the IAIRs and PFRs is based on the 2004/2005 Operations Criteria and Plan. With the exception of the LVE Investigation, the draft Feasibility Reports and draft NEPA/CEQA compliant EIS/EIRs for the investigations may be completed in late 2011. A final EIS/EIR for a 60,000 acre-foot enlargement of Los Vaqueros Reservoir was published in March 2010.

Purpose and Scope of Report

The purpose of this Progress Report is to provide information on the status of the ongoing CALFED surface storage investigations, including the NODOS Investigation, USJRBSI, LVE Investigation, and SLWRI. This report summarizes the status of the studies and potential benefits and effects of example project formulations. The report includes new analyses of potential project formulations and discussion of how the projects fit within current state, federal, and regional water management and Delta initiatives (e.g., BDCP, DHCCP, and the Delta Plan) as part of comprehensive statewide and regional water management solutions. For this report, new analysis was conducted on how potential projects could be operated under new conditions, which are inclusive of the 2008/2009 BOs, and an estimate of potential project benefits was made. This report also provides new preliminary analysis on how benefits of potential projects would be affected by Delta conveyance measures being considered by BDCP/DHCCP and climate change. Finally, this report describes the next steps for the feasibility studies and environmental documentation as required by CEQA and NEPA, and discusses how these steps and processes are affected by the 2009 Comprehensive Water Package.

For each investigation, several different project alternatives are being evaluated as part of the planning, environmental review, and documentation process. For the purposes of this report, one conceptual surface storage project formulation (a package of physical facilities, environmental measures, and operations) is presented for each investigation. This Progress Report is not intended to designate or select any particular project alternative for implementation.

The analyses conducted for this report included an evaluation of potential project benefits with new conveyance in the Delta. BDCP and DHCCP are currently studying the potential of various alternatives for new Delta conveyance but the results of these analyses are not complete at this time. Therefore, analyses for this Progress Report include an example isolated facility in the Delta (hereafter, new Delta conveyance) (See Figure 1-2). The assumptions for the new Delta conveyance facilities were consistent with the October 2009 Draft Bay Delta Conservation Plan (The new Delta conveyance facilities modeled for this report do not designate or preclude selection of a preferred project under BDCP/DHCCP. The assumed facilities provided a sufficiently detailed representation of a potential conveyance configuration for modeling purposes).

DWR consulted with Reclamation and CCWD in the preparation of this report. DWR is a partner with Reclamation in the study of NODOS and USJRBSI, and with Reclamation and CCWD in the LVE Investigation. State legislation limits DWR's participation in the SLWRI; however, DWR does coordinate and review feasibility study reports and environmental documentation developed for the SLWRI. The information for SLWRI presented in this report is summarized from previous Reclamation documents and from operations studies conducted by Reclamation.

This report is not a decision document and is separate from the ongoing feasibility studies and NEPA/CEQA compliance documentation for the surface storage investigations. This report does not include detailed economic or design analysis, comparison of projects, or allocation of project benefits, nor does it provide sufficient information to make determinations on preferred alternatives.

This report provides up-to-date information available at the time this report was drafted. New analyses conducted for this report are for informational purposes only.

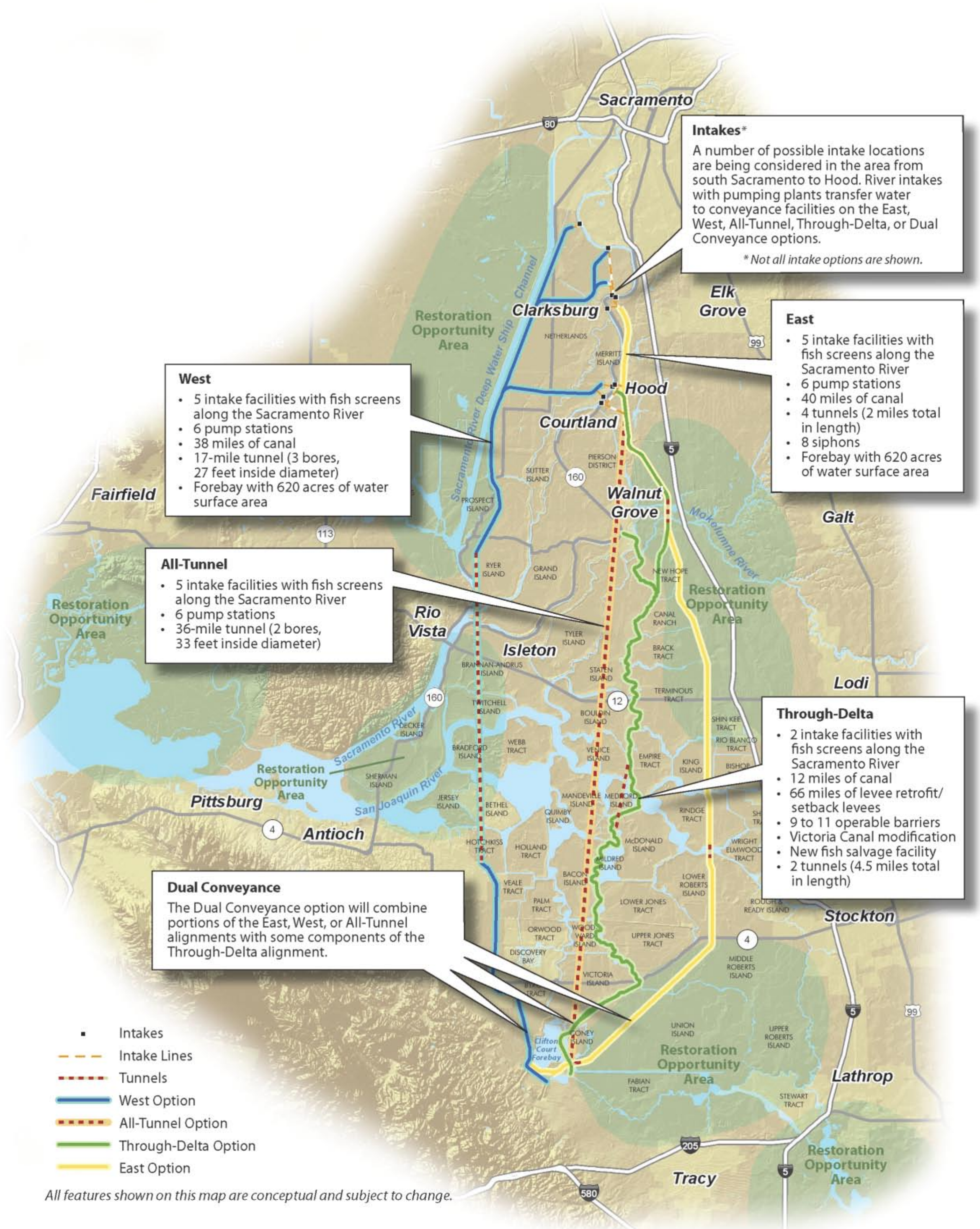

Figure 1-2. Potential Configurations of New Delta Conveyance

Report Organization

This Progress Report is organized by the following chapters:

- **Introduction –** This chapter provides the background information on water management in the state and the surface storage programs and the purpose and scope of the report.
- **Major Water Management Challenges in California –** This chapter describes the major challenges to managing water resources in the state, such as declining ecosystems, drought, water quality, climate change, flood risk, population growth, and a changing Delta.
- **North-of-the-Delta Offstream Storage Investigation –** This chapter summarizes the NODOS investigation feasibility study and presents new information on how changes to physical, biological, and regulatory conditions affect regional and statewide project benefits.
- **Upper San Joaquin River Basin Storage Investigation –** This chapter is similar to the previously described NODOS chapter, but is specific to the USJRBSI.
- **Los Vaqueros Expansion Investigation–** This chapter is similar to the previously described NODOS chapter, but is specific to the LVE Investigation.
- **Shasta Lake Water Resources Investigation –** This chapter is similar to the previously described NODOS chapter, but is specific to the SLWRI.
- **Summary and Next Steps –** This chapter provides a brief summary of the report and a discussion of the next steps in the feasibility studies for the surface storage investigations, including new steps stemming from the 2009 Comprehensive Water Package.

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Chapter 2 Water Management Issues and Challenges

California faces a number of unprecedented water resources management challenges. The California Water Plan stresses urgency and that it is "imperative to act" as California faces "one of the most significant water crises in its history," which is due to declining ecosystems, greater drought impacts, aging infrastructure, increasing flood risk, and impaired water bodies (DWR, 2009a). Additionally, climate change and population growth are further stressing our water systems and will make all of the effects associated with the challenges above more difficult to manage. Finally, the facilities used to convey water around the state face uncertainties. The Sacramento-San Joaquin Delta (Delta) (See Box 2-1 for a list of acronyms and abbreviations used in this section) is in crisis and as the hub of California's water delivery system, the Delta faces many challenges. There is uncertainty about how the Delta of the future will look and how water will be conveyed through the Delta. The status quo is not working. There are many new programs, policies, and stakeholders that will shape the future of the Delta. Water management planners must incorporate these uncertainties, including potential Delta water management solutions, into both statewide and regional planning efforts.

For more than 50 years, Californians have been able to meet water demands primarily through an extensive network of water storage and conveyance facilities, groundwater development, and more recently, by improving water use efficiency and conservation practices (DWR, 2009a). California's large (state/federal) and small (local/regional) water projects work together to meet the needs for the quantity, quality, timing, and location of water uses. California's climate and hydrology make storage of water essential to survival and to the economy as precipitation is unevenly distributed. Every area of the state experiences many dry months without any precipitation each year, generally starting in the spring and lasting into the fall. The northern and mountainous parts of the state receive far more precipitation than the valleys and southern parts of the state. As a result, surface storage reservoirs play a critical role in helping meet the multiple needs of municipal and industrial (M&I), agricultural, and environmental uses in different geographical regions.

Much has been written about the water issues and challenges in California; this chapter begins with a brief summary of some of those issues and challenges as they relate to the water management system in the Central Valley and the Delta and how these challenges will drive improvements to the water system. Additional details on specific regional challenges, particularly in the areas of the Central Valley—the Sacramento Valley, the San Joaquin Valley, and the Delta—are provided in investigation-specific chapters later in this report. Finally, this chapter provides some general discussion of how increasing surface water storage in the Central Valley water system can help meet the interrelated, and sometimes competing, needs of ecosystem restoration, water supply, water quality, flood management, hydropower generation, and recreation.

Declining Ecosystems

Throughout the Sacramento and San Joaquin river basins and the Delta, there are telling signs of the decline and collapse of the ecosystem, from habitat losses to population declines of threatened and endangered species. Of particular importance for this report are the water-related stresses on these important ecosystems, including the following:

- Sufficient flow patterns to support critical life stages of fish populations in Central Valley streams
- Sufficient flows to support fish passage

- Sufficient water supplies for Central Valley wildlife refuges
- Adequate temperatures to support critical life stages of fish populations
- Quality of water necessary for supporting and enhancing desired fish populations

In each of these areas, quantity, quality, and timing of water flows are important factors for supporting and recovering habitat and species.

As a result of the myriad of changes to the system, including water diversions, pollution, invasive species, rising temperatures and loss of habitat, the Sacramento and San Joaquin river systems and the Delta have experienced a serious decline in many important habitats and species. Historic lows of the delta smelt populations and salmon runs in both the Sacramento and San Joaquin rivers are a focal point of concerns. The following sections provide a summary of the nature of the declines in the Delta and the Sacramento and San Joaquin rivers and an overview of responses, including legal, legislative, regulatory, and water management. Appendix D provides a summary of planning efforts in the Delta that will help address ecosystem declines.

Box 2-1. Chapter 2 Acronym and Abbreviation List

AF	acre-feet
BDCP	Bay-Delta Conservation Plan
BO	Biological Opinion
CALFED	CALFED Bay-Delta Program
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
DHCCP	Delta Habitat Conservation and Conveyance Program
DWR	Department of Water Resources
M&I	municipal and industrial
MAF	million acre-feet
NMFS	National Marine Fisheries Service
Reclamation	United States Bureau of Reclamation
SWP	State Water Project
TAF	thousand acre-feet
USFWS	United States Fish and Wildlife Service

Sacramento-San Joaquin Delta

The Delta is home to 750 species of plants and wildlife and 55 species of fish and is the hub of California's water delivery system providing water to farms and more than two-thirds of the state's population. This important estuary is in crisis; a convergence of various factors has diminished the health of the Delta. Despite many efforts to maintain and recover endangered and threatened fish and wildlife species, and protect critical habitat, species continue to decline. The decline of pelagic fish species, including delta smelt, striped bass, threadfin shad, and longfin smelt (See Figure 2-1), has brought the Delta to the attention of many in California and across the nation.

Over the past several decades, the Delta ecosystem has continued to decline, which was dramatically illustrated by the more recent collapse of the delta smelt population and salmon runs associated with the Sacramento and San Joaquin rivers. These declines triggered a number of environmental and legal actions related to the operation of the Central Valley Project (CVP) and State Water Project (SWP) and reduced the ability to convey water through the Delta. Lawsuits and resultant court decisions include the May 2007 *Natural Resources Defense Council et al. vs. Kempthorne et al.* (regarding delta smelt), and December 2008 *Pacific Coast Federation of Fisherman's Association vs. Gutierrez* (regarding salmonid species). These court decisions led to protective measures that resulted in constrained water conveyance and curtailed CVP/SWP Delta exports. For example, in spring 2007 water exports from the Delta were significantly reduced for CVP facilities and halted at SWP facilities for a period of 10 days to protect delta smelt. The Department of Water Resources (DWR) estimated that over 500 thousand acre-feet (TAF) of scheduled deliveries could not be made during this period.

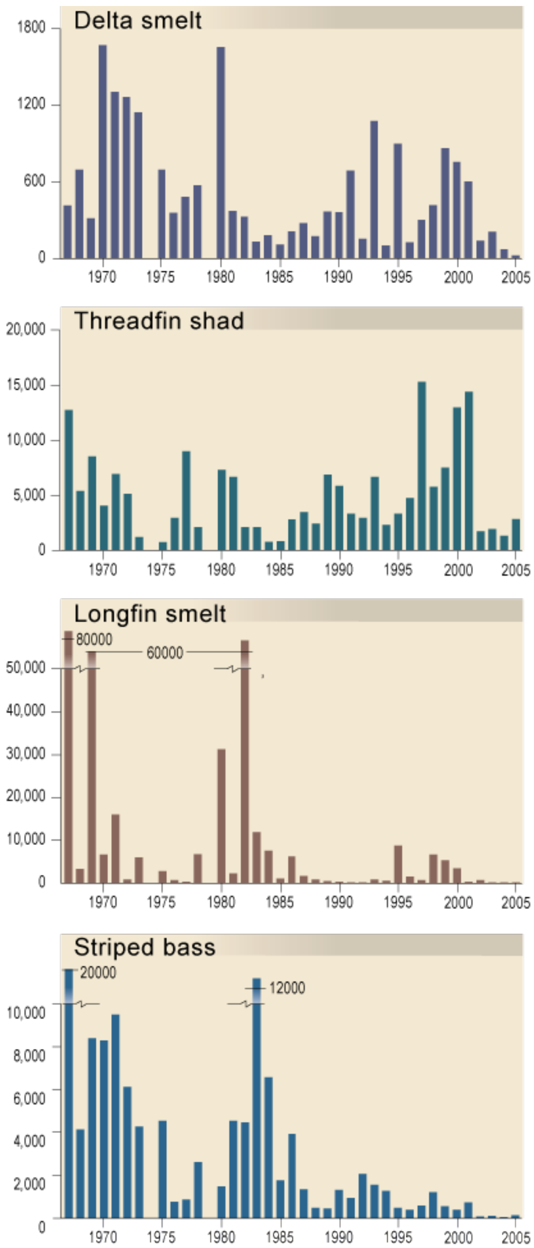

Figure 2-1. Fish Trends Depicting Delta Pelagic Organism Decline, 1967-2005 (Natural Resources Agency, 2007)

In response to these lawsuits and court decisions, the Bureau of Reclamation (Reclamation) and DWR revised their Biological Assessment in May 2008 and the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) recommended actions to protect delta smelt and anadromous fish in their respective 2008 and 2009 Biological Opinions (BO). These new BOs regulate current operations of the CVP and SWP, and place additional constraints on water management and operations in the Sacramento and San Joaquin river basins and the Delta. NMFS calculates that its BO will reduce by 5% to 7% combined the amount of water federal and state projects will be able to deliver from the Delta. In total, court decisions and new regulations have reduced Delta water deliveries by 30%.

Sacramento / San Joaquin River Systems

The Delta is inextricably linked to its major rivers (Figure 2-2). The Sacramento and San Joaquin rivers each face ecosystem restoration challenges, while also providing inflows to the Delta. The Sacramento and San Joaquin rivers and some of their major tributaries are dammed to capture winter runoff and spring snowmelt from California's snowpack and release water when needed. To successfully restore aquatic, riparian, and floodplain communities the natural patterns of erosion, river meander, sediment deposition and scour depend upon seasonal variations in stream flow.

Tributaries to California's large rivers that were once seasonal have become annual streams due to human contributions from wastewater discharge and irrigation runoff. These changes to inflow have modified the historical Delta from a seasonally brackish estuary to a freshwater system that benefits invasive species. Restoring functional ecosystem characteristics will be essential in restoration efforts. Actions can be taken to improve the ecosystem and water supply of the Sacramento and San Joaquin rivers and provide additional benefits to the Delta.

Sacramento River

The Sacramento River is the state's largest as well as California's most important riverine ecosystem. Restoration challenges are strongly tied to ecosystem processes and functions associated with the river and its nearby land areas. The Sacramento River and its tributaries provide essential riparian habitat for many aquatic and terrestrial species including habitat for anadromous fish spawning, holding, and rearing. The valley floor region adjoining the river provides wintering areas along the Pacific Flyway for many varieties of waterfowl. The region also has several wetland and waterfowl preserves that provide nesting and migration areas for threatened avian species that depend upon a reliable water supply. (DWR, 2009a)

Many Sacramento River restoration opportunities have been identified by previous or on-going planning efforts such as the CALFED Bay-Delta Program (CALFED) Ecosystem Restoration Program Sacramento River Ecological Management Zone Vision and the Sacramento River Conservation Area Forum.

San Joaquin River

Unhealthy ecosystem conditions in the San Joaquin River have resulted from a lack of reliable flows in some sections of the river and poor water quality. Tributaries of the San Joaquin River provide the region with high-quality water that constitutes most of the surface water supply. A recent settlement action that resulted in a long-term restoration effort, the San Joaquin River Restoration Program, proposes to restore flows to the San Joaquin River to sustain naturally reproducing Chinook salmon and other fish populations between Friant Dam and the Merced River.

Drought Impacts and Water Supply Reliability

California's water resources are variable, precipitation—the primary source of the state's water supplies—varies from place to place, season to season, and year to year. In any year, the state's water systems may face the threat of too little water to meet needs during droughts or the threat of too much water during floods. Most of California's snow and rain fall in the mountains in the northern and eastern parts of the state, and most water is used in the central and southern valleys and along the coast. The state's ecosystem, agricultural, and urban water users have variable demands for the quantity, timing, and place of use. The state's water distribution systems, made up of local, state, and federal projects and programs, were designed with this variability of natural precipitation and water use in mind. These projects have worked together to make water available at the right places and times, and to manage floodwaters. In the past, this system has allowed California to meet most of its agricultural and urban water management objectives and flood management objectives.

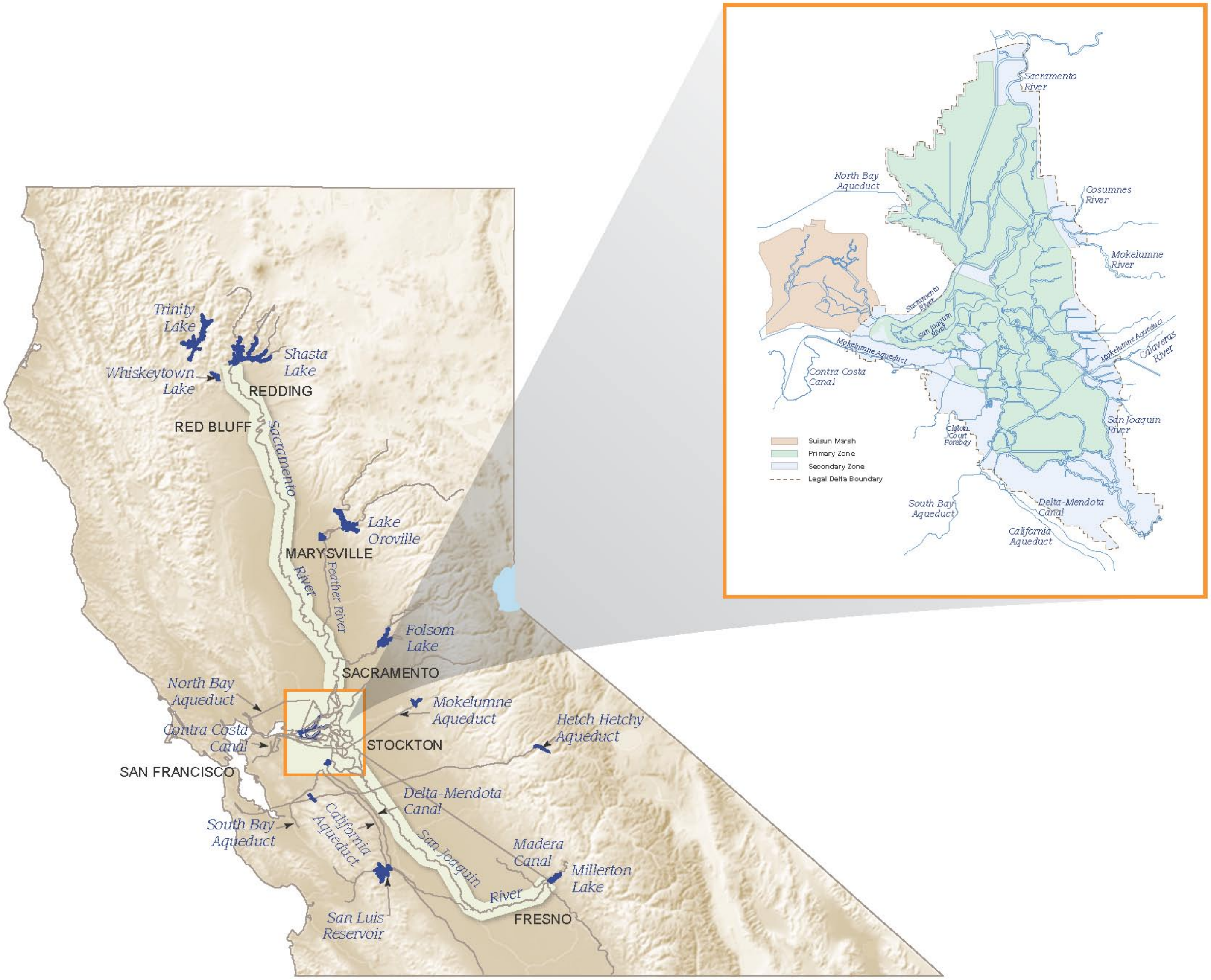

Figure 2-2. The Delta and Sacramento and San Joaquin Rivers

Generally, during a single dry year or two, surface water and groundwater storage can supply most water deliveries, but dry years can result in critically low water reserves. More recently, improved water use efficiency and conservation practices have helped to meet water demands. However, significant water supply and water quality challenges persist. Although some regions have made great strides in water conservation and efficiency, many communities in the state are reaching the limits of their supply with current water systems management practices and regulations. This system is constrained during normal years, but the challenge to make sure that water is in the right place at the right time is at its greatest during dry years. (DWR, 2009a)

Water supply reliability is most affected during drought conditions. The amount of water supplies delivered annually depends on the demand, amount of rainfall, snowpack, runoff, water available in storage, and legal constraints on diversions from the Delta—all of these factors are worsened during drought conditions. The California Water Plan acknowledges that reliability is most challenging during drought conditions, "As competition grows during dry years among water users, water management becomes more complex and, at times, contentious." The strategic plan of the California Water Plan includes 10 fundamental lessons; including, "California needs additional groundwater and surface water storage capacity. Storage gives water managers tremendous flexibility to meet multiple needs and provide vital reserves in drier years."

Water Year 2009 represented the third consecutive dry year for the state. Drought conditions changed California's water management and forced communities to impose mandatory restrictions on water use. During droughts, ecosystems also feel the pressure as less water is available to meet in-stream flow requirements and the temperature of the water increases causing greater impacts to the ecosystem. Droughts affect the state's economy, slowing development projects and forcing growers to fallow land. The California Department of Food and Agriculture estimated that the water shortage caused a $260 million loss to the state's agricultural industry in 2009. Droughts, as well as flooding, may be inherent in California's natural cycles, but their intensity and consequences are worsening. Indeed, in the 25-year period from 1985 to 2010, half of the years have been categorized as dry or critically dry. Warming temperatures and changes in rainfall and runoff patterns may increase the frequency and intensity of droughts. (DWR, 2009a)

Statewide droughts typically occur as a result of multiple dry years. Recent droughts that have seriously affected water supplies include the 1976-1977 drought, which included one of the driest years on record (1977), the 1987-1992 drought, and the current drought. A single dry year is generally manageable because of water in storage. In California, runoff and reservoir storage, which are related, are good indicators of a statewide drought. Runoff for the current drought is 53%, 60%, and 65% of average for water years 2007, 2008, and 2009 respectively. Reservoir storage at the state's major reservoirs during the same period is 78%, 57%, and 69% of average. (DWR, 2009b) Deliveries to water users and water contractors have been substantially reduced.

Challenges are greatest during dry years and droughts, as we have experienced yet again over the past three years. In drier years, water dedicated to the environment is curtailed, and less water is available for agriculture. Greater reliance on groundwater during dry years results in higher costs for many users and more groundwater overdraft. At the same time, water users who have already increased efficiency may find it more challenging to achieve additional water use reductions during droughts. Longer droughts create numerous problems including extreme fire danger, economic harm to urban and rural communities, loss of crops, and the potential for species collapse and degraded water quality in some regions. (DWR, 2009a)

The Central Valley water system is designed with carry-over water storage in reservoirs to lessen the impacts of drought. Water is stored in wetter years for use in drier years. Similarly, the Central Valley's groundwater basins provide storage and a buffer for the effects of drought. Droughts also affect different areas of the state in different ways. In some years, water shortages in one area are not experienced by other areas. California's water system is designed to create some flexibility to address differing regional impacts through short-term transfers of water to minimize drought impacts.

Impaired Water Bodies

Water quality issues and conflicts in the Central Valley water system present significant challenges for providing adequate and appropriate water supplies for the environment and M&I and agricultural users. The fundamental challenge is the mismatch of water quality needs with the quality of available supplies.

In many areas surface water and groundwater are impaired by natural and human-made contaminants that can threaten human health, degrade the natural environment, increase water treatment costs, and effectively reduce the available water supply. (DWR, 2009a) As water flows from upstream storage reservoirs through the Central Valley to the Delta, it is impaired by increasing pollutants from discharges and runoff and increasing temperatures from warmer weather at lower elevations.

Water storage reservoirs in the Central Valley capture high quality water with low level of pollutants and low temperature and make that water available at appropriate times for the environment, agriculture, or M&I use. The storage reservoirs are operated to manage water quality in the rivers and the Delta to meet multiple needs. For example, existing off-stream water storage reservoirs can store high quality water for use when instream water quality declines in late summer and fall.

Key water quality challenges in the Central Valley include the following issues:

- Improving and maintaining high quality of drinking water supplies for M&I uses
- Achieving appropriate levels of salinity and organics for Central Valley habitats, particularly in the Delta
- Maintaining low temperature flows for critical life stages of fish populations in Central Valley tributaries
- Maintaining appropriate levels of dissolved oxygen to support ecosystem health

Most significantly, these water quality issues are frequently in conflict. For example, M&I users of Delta water supplies seek to maintain low levels of nutrients and organics while ecosystem needs in the same area may require higher levels of nutrients and organics and important habitat, such as tidal marsh, increase dissolved organics in the water supply.

Changes in temperature and precipitation patterns caused by climate change will also affect water quality, and ultimately, ecosystems. Increased water temperatures reduce the dissolved oxygen levels and success of aquatic life that have a low tolerance for variable and warmer in-stream temperature. Higher water temperatures accelerate certain biological and chemical processes, increasing the growth of algae and microorganisms, and affect water treatment processes. Elevated water temperatures will distress many fish species and could require additional cold water reservoir releases to mitigate these higher temperatures.

Changes in the timing of river flows from climate change may affect water quality and beneficial water use. At one extreme, flood peaks may cause more erosion, resulting in higher turbidity and concentrated pulses of pathogens and other pollutants. At the other extreme, lower summer and fall flows may provide less contaminant dilution. These changes will require new approaches to manage point and nonpoint source pollution.

Additionally, saltwater intrusion associated with sea level rise caused by climate change will affect Delta water supplies and aquatic habitat. An increase in the penetration of seawater into the Delta will further degrade drinking and agricultural water quality and alter ecosystem conditions. With the current water management system, more freshwater releases from upstream reservoirs will be required to repel seawater intrusion to maintain salinity levels for M&I and agricultural uses. Alternatively, changes in upstream and in-Delta diversions, exports from the Delta, and conveyance through or around the Delta may be needed. Sea level rise may also affect drinking water supplies for coastal communities due to the intrusion of seawater into overdrafted coastal aquifers.

Climate Change

The inherent variability in location, timing, amount, and form of precipitation has always led to uncertain predictions of water supplies in California. Climate change introduces further uncertainty and risk in the availability of water supplies for California. Global warming is likely to significantly affect the hydrologic cycle, changing California's precipitation pattern and amount from that shown by the historical record. There is evidence suggesting that some changes have already occurred, such as earlier Sierra snowmelt, runoff patterns shifting from the spring to the winter, and an increase in winter flooding levels and frequency, as well as the length and frequency of droughts. These changes will place more stress on the reliability of existing water management and supply systems.

The greatest effect of climate change will be the loss of water storage from the Sierra snowpack (See Figure 2-3) and how the remaining water resources are managed. Snowmelt provides an annual average of 15 million acre-feet (MAF) of water, slowly released between April and July each year. Much of the state's water infrastructure was designed to capture the slow spring runoff and deliver it during the drier summer and fall months. Warmer winters with less snow and more rain may result in more late winter and early spring runoff and less late spring and early summer runoff requiring alteration of how the water system is currently operated.

Water management in California has been based on the assumption that the past is the best predictor of the frequency, duration, and severity of future floods and droughts. Managers of California's historical water landscape believed they understood the variability of storm events and used the historical record to predict the future management decisions based on the storage available. Not only were water managers using past hydrology to make decisions, California's reservoirs and water delivery infrastructure were designed using historical hydrology—based on an assumption that the past is a good guide to the future. With climate change that assumption is no longer valid. (DWR, 2009a)

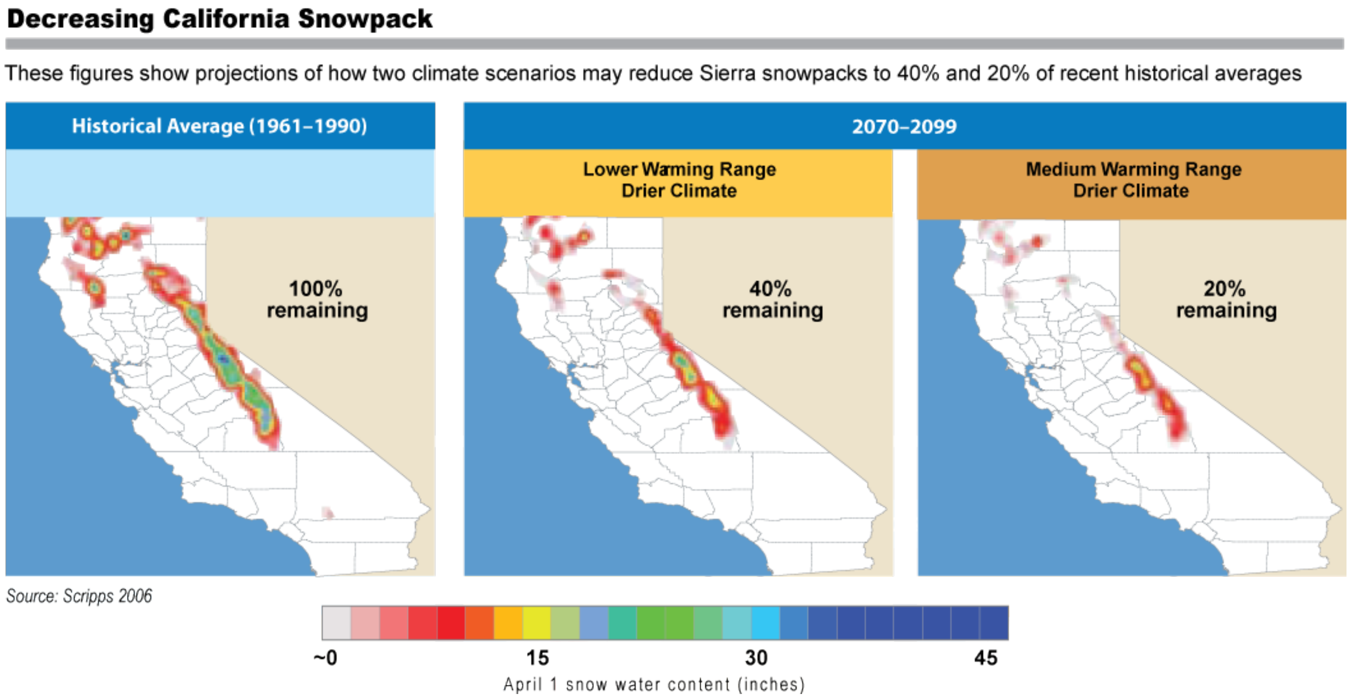

Figure 2-3. Decreasing California Snowpack

The California Climate Change Center issued a report in August 2009 titled "Using Future Climate Projections to Support Water Resources Decision Making in California." Analysis conducted for the report indicated that due to climate change:

1. Reservoir carryover storage is expected to be reduced by 15% to 19% by mid-century and by 33% to 38% by the end of the century.
2. A water shortage worse than the one during the 1977 drought could occur in one out of every six to eight years by mid-century and one out of every three to four years by the end of the century.
3. Annual Delta exports are expected to be reduced by approximately 7% to 10% by 2050 and by 21% to 25% by the end of the century.
4. The SWP and CVP are expected to be more vulnerable to operational interruption.

These changes resulting from climate change will amplify the other water management challenges described in this chapter and alter the timing and availability of water resources in California.

Increasing Flood Risk

California's water distribution system is inextricably integrated with the flood management system; water is conveyed down and through the Sacramento and San Joaquin rivers and the Delta through river channels and sloughs that are confined by levees and many multipurpose water supply reservoirs are operated to provide downstream flood protection. Water storage behind Central Valley reservoirs is a critical component of flood management throughout the Central Valley.

Many of the multipurpose storage facilities contribute to flood management in the Sacramento and San Joaquin river basins. Reservoir operation is essential for management of floodwaters within the Central Valley. Reservoirs can reduce peak discharges by retaining flood waters behind dams and making controlled releases that can be handled by the system. Proper reservoir operation can alleviate flood damages downstream. The United States Army Corps of Engineers establishes seasonal flood reservation storage and rules for the operation of flood storage in reservoirs with flood storage capacity. For example, Shasta Lake on the Sacramento River and Millerton Lake on the San Joaquin River can provide 1.3 MAF and 390 TAF of flood control space, respectively, during the flood season. Oroville Dam, which is the keystone of the SWP, is also identified as part of the State Plan of Flood Control and provides 750 TAF of seasonal flood control space. (DWR, 2010)

Climate change may worsen the state's flood risk by a shift toward more intense winter precipitation and higher peak flood flows. Increasing temperatures and receding snowlines related to climate change will cause the Sierra Nevada watersheds to contribute more precipitation to peak storm runoff and subsequently high-frequency flood events (e.g., 10-year floods) in particular may increase. Scientists project greater storm intensity, resulting in increased direct runoff and flooding. (DWR, 2009a)

Much of the Delta consists of islands that are below sea level and protected by levees. Increasing flood flows and rising sea levels as a result of climate change will increase pressure on fragile levees and will pose a significant threat to water quality. Catastrophic levee failures have great potential to inundate Delta communities and interrupt water supplies throughout the state. Based on work conducted by DWR's Delta Risk Management Strategy, a large earthquake in or near the Delta could likely result in the failure of multiple Delta islands. Levee failures of multiple Delta islands could threaten the drinking water supply of 24 million Californians, California's agriculture industry, tens of thousands of homes, and major transportation corridors, and result in significant environmental impacts, including the permanent loss of critical habitat for endangered species around the Delta.

Following a Delta levee failure, particularly an event that involves multiple breaches and more than one flooded island, decisions must be made to manage Delta inflows and outflows, especially concerning Delta water quality and its effect on water exports, Delta island water, ecosystem functions, and economic disruption. Maintaining Delta water quality when several islands are flooded requires more than the usual inflow of fresh water because of the extra volume of tidal flow under breach conditions. Extensive damage to Delta levees may require re-operation of SWP, CVP, and other surface water reservoirs. Re-operation may include increasing freshwater flows to the Delta (requiring determinations on quantity and schedule for releases) or releasing emergency storage for delivery to water users. Releases during an emergency must be balanced with the need to save water for environmental needs, other water users, future exports, and protection against dry years or a prolonged disruption of Delta exports. Reservoirs upstream of the Delta may be re-operated to provide freshwater flushing flows, whereas reservoirs downstream of the Delta may increase deliveries to water users due to the reduction of exports from the Delta. Some reservoirs maintain storage for emergency water supply. For example, between 44,000 acre-feet (AF) and 70,000 AF of the Los Vaqueros Reservoir are reserved for emergency purposes depending on the water year type.

Population Growth

Per the California Water Plan, "*Conditions today are much different than when most of California's water systems were constructed; and upgrades have not kept pace with changing conditions, especially considering growing population; changing society values, regulations, and operational criteria; and the future challenges accompanying climate change.*" Indeed, the major water systems were designed more than 30 years ago to serve 16 million residents, now the systems serve more than 38 million residents and are struggling to meet the needs of M&I, agriculture, and the environment.

Population growth is a major factor influencing current and future water uses. The state's population continues to grow, estimated by the Department of Finance to increase to about 59.5 million by the year 2050. Population is growing while available water supplies are static, or may even be decreasing. We must adapt and evolve California's water systems more quickly and effectively to keep pace with ever changing conditions now and in the future. (DWR, 2009a)

Uncertainties of Delta Water Management

To address the long-term needs of a sustainable Delta ecosystem and improved water conveyance, the Bay-Delta Conservation Plan (BDCP) and Delta Habitat Conservation and Conveyance Program (DHCCP) are evaluating ecosystem restoration and habitat conservation opportunities associated with different water conveyance options in the Delta. The BDCP and DHCCP are preparing environmental and engineering studies to develop a sustainable resolution to the Delta ecosystem decline and Delta export and conveyance constraints. A Public Draft Environmental Impact Statement/Environmental Impact Report for the BDCP is expected next year. Solutions to Delta ecosystem restoration and improved water conveyance needs may result in changes to the pattern and timing of Delta water diversions, affecting water quality and hydrodynamic conditions in the Delta. As uncertainties regarding these plans and policies are resolved, assumptions will be refined, which may change the basis of comparison for or magnitude of the accomplishments of the initial alternatives plans considered by the surface storage investigations.

Water Management Issues and Challenges and the CALFED Surface Storage Investigations

The Central Valley water management system will need greater flexibility to meet the above challenges in the future. The following is a brief list of some of the ways reservoir storage can contribute to addressing statewide and regional water needs for people and the environment:

- Managing the timing of water availability to better match demand/water use (seasonally and year-to-year to meet drought needs)
- Managing environmental water flows, timing, and temperature in river systems
- Managing the quality of water for different purposes, including temperature
- Promoting conjunctive use of surface water and groundwater
- Providing emergency water supply
- Collecting flood flows to protect resources from damage
- Providing hydropower generation or flexible generation opportunities
- Adapting to loss of snowpack storage
- Enhancing regional self sufficiency
- Supplementing local water supplies, conservation, reuse, and desalination

Some of these storage benefits cannot be addressed with, or would not be addressed as effectively as with, other water management strategies such as conservation, groundwater storage, and recycled water.

The water management challenges described in the sections above greatly influence the CALFED surface storage investigations. Some of the water management challenges may be directly addressed by planning objectives formulated specifically for each of the storage investigations. While other challenges may influence planning decisions and future project operations as the investigations continue and potential projects are implemented. All of the water management challenges affect each of the investigations, but to varying degrees. The investigations require creativity, adaptability, and the ability to look at surface storage in new and unique ways to address these challenges.

The CALFED storage investigations are each studying the potential contributions storage could make to address California water challenges. The following lists state and regional contributions each storage project could provide to address the above challenges:

North-of-the-Delta Offstream Storage Investigation

- Increased water supply reliability for urban and agricultural water users during average and dry years
- Increased flows for threatened fish populations in the Sacramento River and the Delta
- Increased cold water flows for fish populations in the Sacramento River
- Improved Delta water quality
- Increased water supplies for wildlife refuges
- Improved water management and operational flexibility in the face of uncertain and changing conditions
- Flushing flows for the Delta to reduce salinity during Delta levee failures
- Coordinated operations of Sites Reservoir with existing reservoirs to provide flood control benefits
- Flexible generation benefits to integrate renewable generation into the electric grid

Upper San Joaquin River Basin Storage Investigation

- Increased water supply reliability and system operational flexibility for agricultural, urban, and environmental water users in the CVP and SWP service areas
- Improved cold water pool management for enhancing water temperatures in the San Joaquin River below Friant Dam
- Increased San Joaquin River flows in critically dry years
- Reduced flood damages
- Provide emergency water supply to south-of-Delta water users during a Delta supply disruption
- Improved San Joaquin River and Delta water quality
- Improved water quality for urban water users in the San Joaquin Valley and other areas
- Improved water management flexibility in the face of uncertain and changing conditions

Los Vaqueros Expansion Investigation

- Improved operational flexibility to protect fish at export pumps
- Increased water supply reliability for Bay Area water agencies
- Improved water quality for Bay Area water agencies

Shasta Lake Water Resources Investigation

- Increased cold water flows for Sacramento River fisheries
- Improved water supply reliability for agricultural and M&I customers and for environmental purposes
- Increased Sacramento River flood protection
- Improved Sacramento River and Delta water quality

The remaining sections of this report will describe how each surface storage investigation has been conceived to explicitly improve both ecosystems and water supply reliability regionally and throughout the state and how potential surface storage projects could add flexibility and contribute to solutions to improve water management in California.

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Chapter 3 North-of-the-Delta Offstream Storage Investigation

The Department of Water Resources (DWR), the U.S. Bureau of Reclamation (Reclamation), and local partners are investigating potential offsteam storage north-of-the-Delta in the Sacramento Valley (See Box 3-1 for a list of acronyms and abbreviations used in this section). The investigation purpose is to evaluate the feasibility of northern Sacramento Valley storage to improve water supply and water supply reliability, improve Sacramento-San Joaquin Delta (Delta) water quality, and increase the survival of anadromous fish and other aquatic species. Much of the information presented here is summarized from the North-of-the-Delta Offstream Storage (NODOS) Investigation Plan Formulation Report (PFR) (Reclamation, 2008a). However, this section also summarizes new analyses for the NODOS Investigation reflecting recent water management changes, including the 2008 US Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) Biological Opinions (BO). Sensitivity analyses are also presented on proposed new Delta conservation and conveyance actions. Climate change impacts to the potential benefits and operations of the example project formulation are also described.

Study Areas

NODOS would affect environmental and water resources in various ways in different geographic areas. To effectively evaluate these differing effects, three study areas were identified for the NODOS Investigation: the Primary Study Area, the Secondary Study Area, and the Extended Study Area, as described below.

The Primary Study Area (See Figure 3-1) for the NODOS Investigation encompasses the upper Sacramento River and the northern Sacramento Valley and includes watersheds flowing into the upper Sacramento River from Colusa, Tehama, and Glenn counties, as well as smaller portions of Shasta, Sutter, and Butte counties. It includes the Sites Reservoir inundation area and new project facilities (e.g., dams, fish screens, pipelines, pumping/power plants, recreation areas, road relocation areas, and borrow areas).

The Secondary Study Area includes the State Water Project (SWP) and Central Valley Project (CVP) facilities that could experience reservoir water surface elevation fluctuations and stream flow changes downstream from their facilities. Those potential changes could occur as a result of the coordinated and integrated operation of a NODOS project facilities with those state and federal projects located on the American River, Trinity River, Sacramento River, Clear Creek, Spring Creek, Feather River, and the Delta.

The Extended Study Area includes the entire service areas of the SWP and CVP. This is because one of the NODOS primary objectives of improved water supply reliability has the potential for long-term direct and indirect effects within those two service areas.

The effects of a NODOS project in the three study areas will be analyzed in the draft and final Environmental Impact Report (EIR) and Environmental Impact Statement (EIS).

Box 3-1. Chapter 3 Acronym and Abbreviation List

AF	acre-feet
BO	Biological Opinion
CALFED	CALFED Bay-Delta Program
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
Delta	Sacramento-San Joaquin Delta
DWR	Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ERA	Ecosystem Restoration Account
ERP	CALFED Ecosystem Restoration Program
^{o}F	degrees Fahrenheit
GCID	Glenn-Colusa Irrigation District
IAIR	Initial Alternatives Information Report
M&I	municipal and industrial
MAF	million acre-feet
mg/L	milligrams per liter
msl	mean sea level
NA	not applicable
NEPA	National Environmental Policy Act
NM	not modeled
NMFS	National Marine Fisheries Service
NODOS	North-of-the-Delta Offstream Storage
PFR	Plan Formulation Report
Reclamation	United States Bureau of Reclamation
ROD	Record of Decision
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TC	Tehama-Colusa
TCCA	Tehama-Colusa Canal Authority
TDS	total dissolved solids
TRR	Terminal Regulating Reservoir
USFWS	United States Fish and Wildlife Service
WRC	Water Resources Council

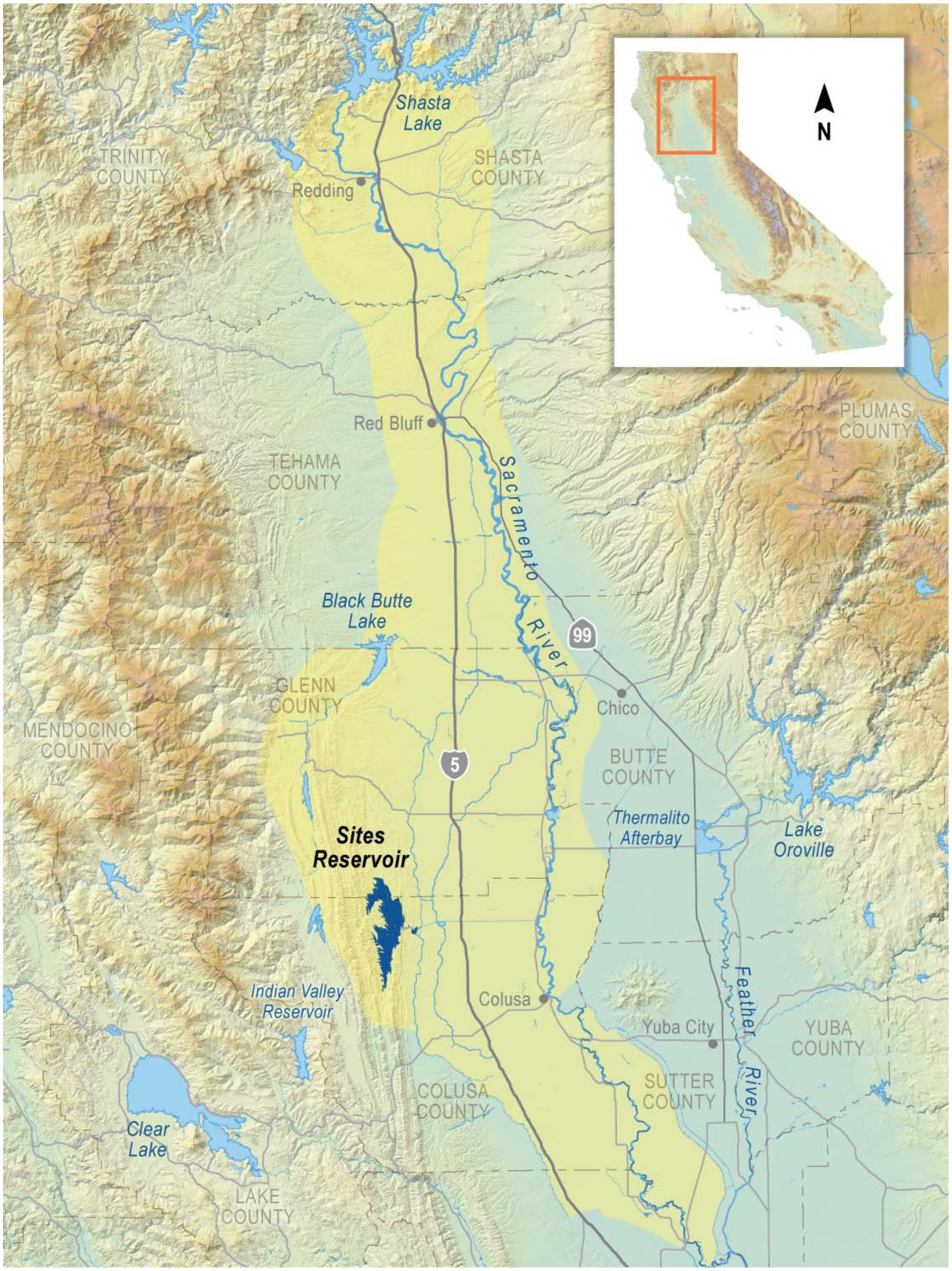

Figure 3-1. NODOS Investigation Primary Study Area

Project Objectives

The NODOS PFR describes problems, needs, and opportunities in the study areas that served as the basis for the NODOS Investigation planning objectives. Some of the problems and needs are also described more generally in Chapter 2. This section briefly summarizes the problems, needs, and opportunities for the NODOS Investigation and presents NODOS planning objectives.

Water Supply and Water Supply Reliability

The California Water Plan and the CALFED Bay-Delta Program (CALFED) Record of Decision (ROD) both recognized the need for increased water supply and water supply reliability, especially during dry years. SWP and CVP contractors are subject to dry-year deficiencies and are especially vulnerable to droughts. During extended droughts, decreased agricultural deliveries often force water users to either use groundwater to replace surface water supply or remove agricultural acreage from production (DWR, 2005). Decreased municipal and industrial (M&I) deliveries often result in rationing or acquisition of other temporary sources.

In the 1990s, protective actions, including the Central Valley Project Improvement Act (CVPIA) and the *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (SWRCB, 1995), reduced the ability of the SWP and CVP to contribute to statewide water supply reliability. CALFED estimated that these two protective actions reduced water contract deliveries by more than 1 million acre-feet (MAF) annually during dry periods. More recently, the 2008 USFWS and 2009 NMFS BOs further reduced the annual delivery capability of the SWP and CVP.

Similar to M&I and agricultural water supply, Level 4 water supplies for California's wildlife refuges are not reliable. CVPIA called for the CVP to provide two types of refuge water supply: Level 2, which was to be provided by CVP yield and incremental Level 4, which was an additional amount above Level 2 and was to be acquired. According to estimates by the USFWS, only about 50% of the incremental Level 4 supplies are acquired each year from willing sellers, partly due to too few willing sellers and/or insufficient funding.

The NODOS Investigation is evaluating the use of offstream storage to provide additional water supply and improve water supply reliability for M&I and agricultural users and wildlife refuges. Water stored in the winter during higher flow conditions in the Sacramento River would be available for use throughout the year and allow additional water to be carried over in storage from year to year. Additional water in storage is especially helpful for mitigating the effects of drought, or multiple dry years.

Survival of Anadromous Fish and Other Aquatic Species

Loss of riparian habitat, the operations of dams and pumping facilities, polluted runoff, and changes in geomorphology have negatively affected populations of anadromous fish and other aquatic species in the Sacramento River and Delta. Fish species of primary concern that are affected by water operations in the Sacramento River and Delta include winter-run Chinook salmon, delta smelt, river lamprey, Central Valley steelhead, spring-run Central Valley Chinook, fall and late fall-run Chinook, green sturgeon, and Sacramento splittail. Non-listed fish species that also may be affected by water operations include striped bass, Pacific lamprey, white sturgeon, and American shad.

The NODOS Investigation is analyzing the ability to change systemwide CVP/SWP operations to improve the reliability of the projects in meeting reasonable and prudent alternatives of the 2008/2009 BOs, such as anadromous fish migration flows and cooler water for fish spawning habitat. Additionally, the NODOS Investigation can provide considerable benefits to fish and other aquatic species by accomplishing some of the objectives identified in the CALFED Ecosystem Restoration Program (ERP). The ERP adaptive management implementation approach, which supports the flexible use of environmental water, has been accommodated in NODOS planning by dedicating a NODOS storage allocation to ERP and BO objectives. A potential NODOS project may benefit anadromous fish and other aquatic species by providing additional flows in the Sacramento River and Delta for environmental purposes and increasing the cold water pool at Shasta Lake.

Delta Water Quality

The Delta is the diversion point for drinking water for millions of Californians, is critical to California's agricultural sector, and supports a diverse and unique ecosystem. As such, the quality of water in the Delta is very important. Typically, April through July are the most favorable months for the Delta to be used as a source of drinking water. Outflow from natural runoff is usually high enough during this period to push seawater out of the Delta. This period is also outside of the peak loading time for agricultural drainage. Management actions taken to address fishery concerns have resulted in a shift in exports from the higher water quality spring months to the typically lower water quality fall months, with a corresponding degradation in delivered water quality.

Improved water quality in the Delta is needed for drinking water, agriculture, and ecosystem restoration. The composition requirements of each end use vary, but the key indicators of Delta water quality are salinity, toxins, and agricultural drainage components. Habitat quality in the Delta depends on many of these same factors and, more specifically, the survivability of fish and other aquatic species depends on the water quality of the estuary. The NODOS Investigation is evaluating methods to improve water quality by providing supplemental flows of high quality water when water quality is impaired.

Opportunities

Generally, accomplishing objectives associated with opportunities have a lower priority in the project formulation process than achieving the objectives associated with problems and needs. The NODOS Investigation recognizes opportunities to accomplish hydropower/flexible generation, recreation, flood damage reduction, and emergency water objectives.

Planning Objectives

Based on the problems, needs, and opportunities identified for the NODOS Investigation, three primary and three secondary planning objectives have been developed. Identified problems and needs have become primary objectives, while opportunities have become secondary objectives.

Primary Planning Objectives

- Increase water supplies to meet existing contract requirements, including improved water supply reliability, and provide greater flexibility in water management for agricultural, environmental, and M&I users

- Increase the survival of anadromous fish populations in the Sacramento River, as well as the survivability of other aquatic species
- Improve drinking and environmental water quality in the Delta

While meeting the primary planning objectives, the NODOS Investigation will recognize opportunities to accomplish the following:

Secondary Planning Objectives

- Provide flexible generation benefits to facilitate reliable operation of statewide power grid with an ever increasing percent of wind and solar generation
- Develop additional recreational opportunities in the Primary Study Area
- Create incremental flood damage reduction opportunities in support of major northern California flood control reservoirs

Project Formulation and Initial Alternatives

The formulation of initial alternative plans for the NODOS Investigation began with concepts identified in the CALFED ROD (CALFED, 2000b) and continued with the NODOS Initial Alternatives Information Report (IAIR) (Reclamation and DWR, 2006). The IAIR was the first stage in the federal planning process, which identified many features and activities that met the planning objectives. The IAIR summarized the preliminary screening of alternative reservoir locations, conveyance systems, and other features as potential candidates for providing storage within the northern Sacramento Valley. Recognizing the limited scope of the IAIR and the iterative nature of the planning process, the NODOS PFR re-examined the problems and needs, planning objectives and constraints, and provided a more complete evaluation of potential project alternatives. The PFR identified a No-Action Alternative Plan and eight Initial Action Alternative Plans:

- Three initial action alternatives with a water supply focus (WS1A, WS1B, and WS1C)
- Two initial action alternatives with an environmental enhancement focus to improve the survival of anadromous fish and other aquatic species (AF1A and AF1B)
- Two initial action alternatives with a water quality focus (WQ1A and WQ1B)
- One initial action alternative with fish enhancements and operations designed to maximize water supply, fishery, and water quality benefits (WSFQ)

Each of the initial action alternatives met the three primary objectives, but to varying degrees. The “focus” indicated above identifies the relative priority of the use of the facilities associated with NODOS. Several features were common to all of the initial action alternative plans, including a 1.8 MAF Sites Reservoir, two major dams and nine saddle dams, and appurtenant features (See Figure 3-2).

Each of the initial action alternative plans includes dedicated storage allocations to ERP objectives. The NODOS planning team identified ERP objectives that could be supported by implementing a potential NODOS project. Ultimately, the selected ERP objectives were incorporated into the operations strategy for the initial action alternatives.

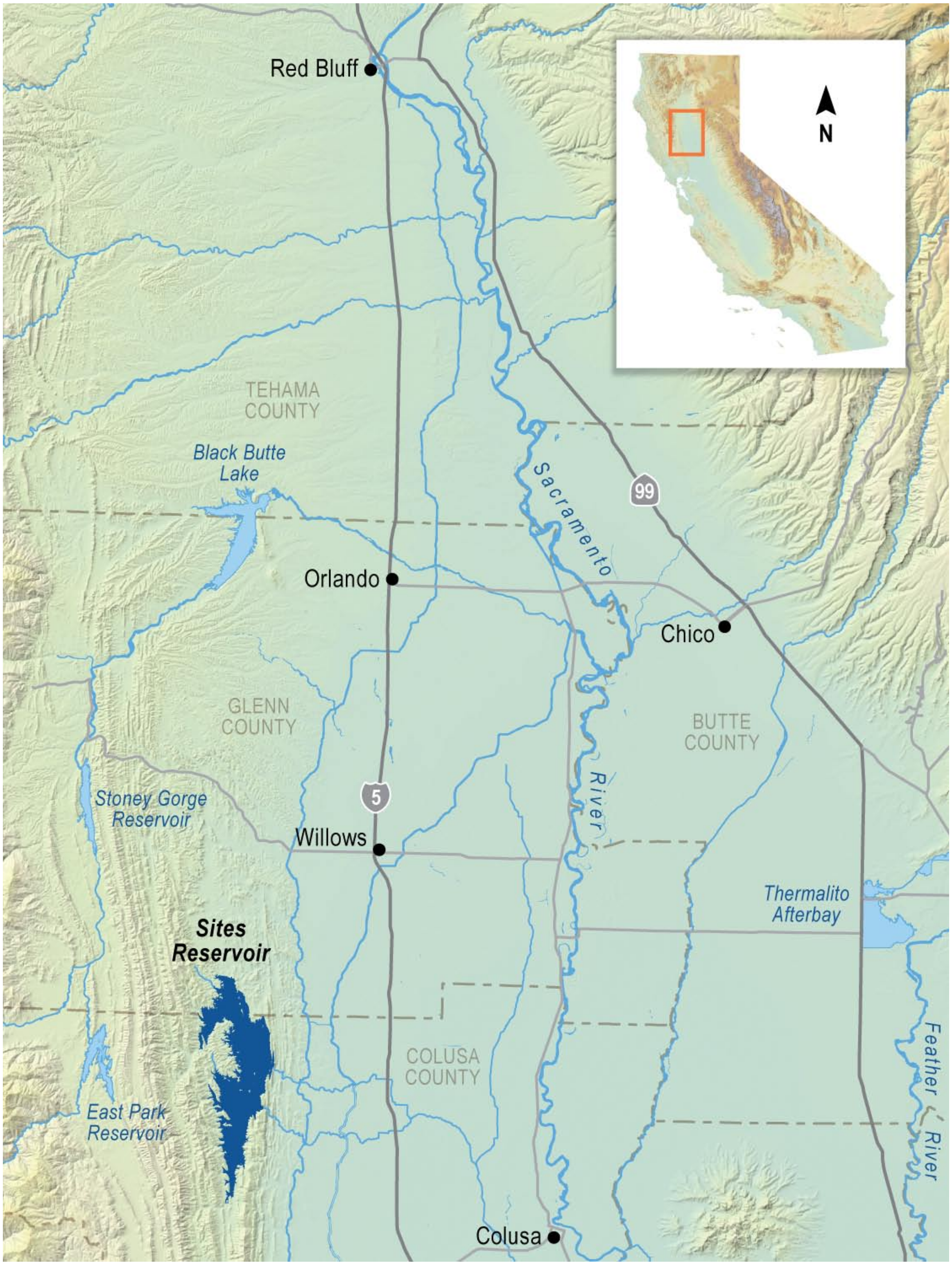

Figure 3-2. Sites Reservoir Project Location

As summarized in the PFR, each of the initial action alternative plans was formulated to address the NODOS Investigation's planning objectives and constraints. The PFR presented a preliminary evaluation of initial alternative plans based on the benefits, costs, and criteria of completeness, effectiveness, efficiency, and acceptability, as identified in the federal planning guide *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC, 1983). Based on the analysis of accomplishments, benefits, and costs and comparison of alternative plans using the four federal planning criteria, the PFR suggested that three of the eight initial action alternative plans be recommended for additional investigation in the feasibility study:

- Initial Action Alternative Plan WSFQ
- Initial Action Alternative Plan WS1A
- Initial Action Alternative Plan WQ1B

As with all the surface storage studies, NODOS alternative analysis and evaluation is an iterative process and as conditions change and new information becomes available previously screened or new measures and alternative plans may be added. Future evaluations may include the optimization of any of the alternatives carried forward in the feasibility study. When all relevant analyses have been completed, a Recommended Plan and the rationale for selection will be identified in the draft Feasibility Report and EIS/EIR.

Example Sites Reservoir Project Formulation Features and Costs

This section describes an example Sites Reservoir project formulation that focuses on the broadest range of benefits. The example Sites Reservoir project formulation is most similar to Initial Action Alternative Plan WSFQ from the PFR. Facilities and costs are generally the same. However, operations have been modified to account for new regulations in the Sacramento River and the Delta. This example project formulation allocates water in a way that meets the three primary objectives, ecosystem restoration, water supply, and water quality, somewhat equally. In addition, the example Sites Reservoir project formulation incorporates measures that would provide benefits to anadromous fish, including abandoned gravel mine restoration, spawning gravel replenishment, and instream aquatic habitat improvements.

The following sections summarize project features and costs for an example Sites Reservoir project formulation.

Example Sites Reservoir Project Formulation Project Features

Sites Reservoir would be an offstream storage reservoir. As noted previously, Sites Reservoir storage capacity is 1.8 MAF and is formed by two major and nine saddle dams. The example Sites Reservoir project formulation would include a proposed Delevan Pipeline (2,000-cubic feet per second [cfs] diversion and 1,500-cfs release capacities) to supplement the existing Tehama-Colusa Canal (2,100-cfs capacity near Sites) and Glenn-Colusa Irrigation District Canal (1,800-cfs capacity near Sites), to convey water to and from the reservoir (See Figure 3-3). All diversions to storage are conveyed through an enlarged Funks Reservoir that would serve as a forebay and afterbay for the Sites Pumping Plant and be used to regulate inflow or releases to and from Sites Reservoir. Although not included in this example project formulation, a large or separate downstream forebay/afterbay is under investigation to see if flexible generation benefits can be increased with this configuration.

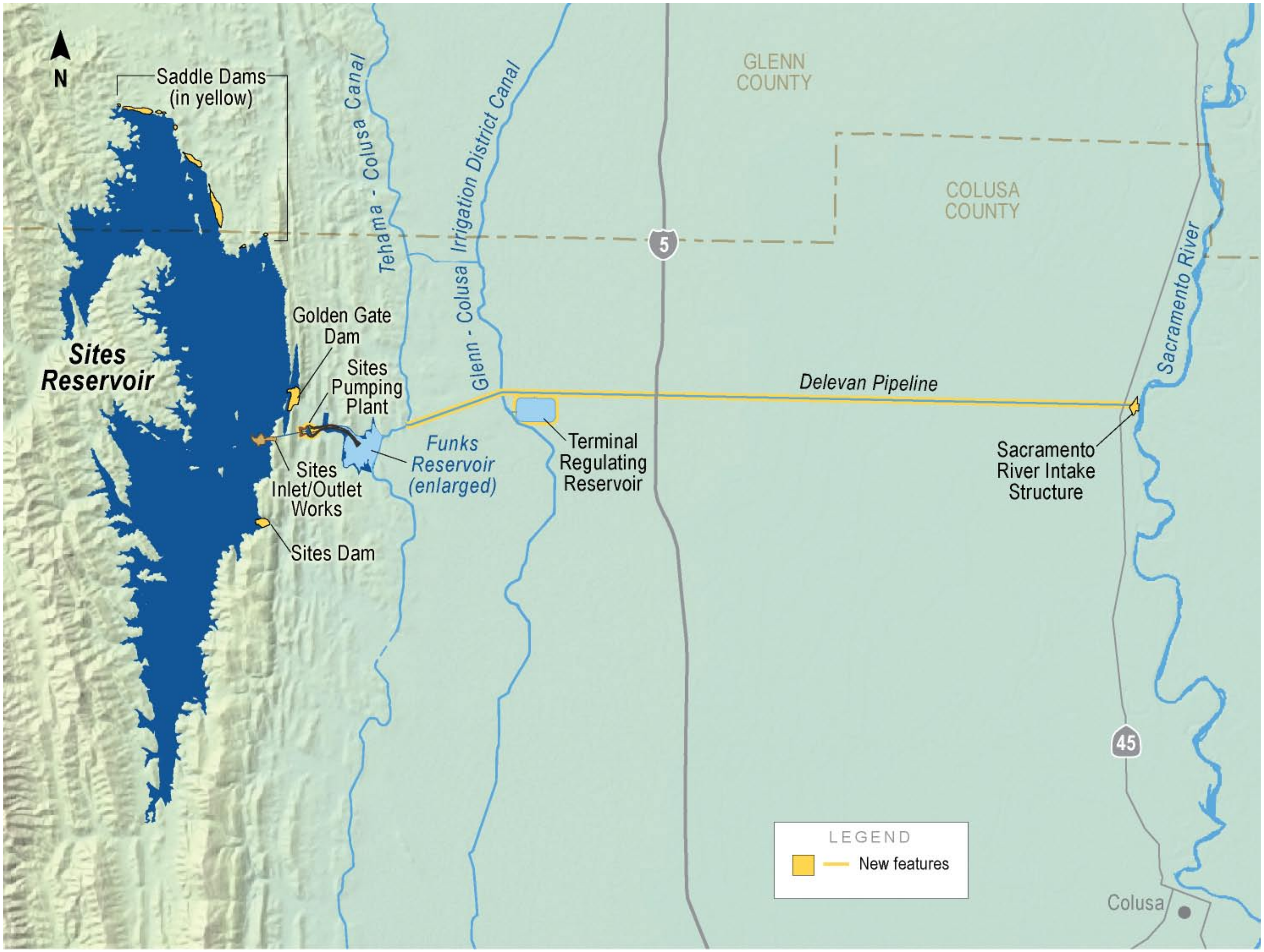

Figure 3-3. Sites Reservoir Inundation Area and Project Features

The example Sites Reservoir project formulation also would incorporate the following three measures that do not require supplemental water from Sites Reservoir to benefit anadromous fish:

- **Abandoned Gravel Mine Restoration:** The example Sites Reservoir project formulation would include acquiring, restoring, and reclaiming inactive gravel mining sites along the Sacramento River near the Primary Study Area. Restoration activities would be conducted in a manner to emulate natural conditions, encourage spawning and rearing, and prevent stranding.
- **Spawning Gravel Replenishment:** The example Sites Reservoir project formulation would include replenishing spawning-sized gravel in the Sacramento River between Keswick Dam and Red Bluff.
- **Instream Aquatic Habitat Improvements:** The example Sites Reservoir project formulation would include restoring instream habitat along the lower arms of the Sacramento River. This activity would include improvements for shallow, warm-water habitat areas, spawning and rearing areas, and overall instream habitat conditions.

A summary of major project features of this example project formulation are listed below in Table 3-1.

Example Sites Reservoir Project Formulation Project Costs

The estimated capital cost for a new surface storage project at Sites Reservoir with a Delevan Pipeline as identified for the example Sites Reservoir project formulation is approximately $3.62 billion dollars (presented in 2007 dollars). Cost estimates include facilities costs, unlisted items, contingencies, indirect costs, mitigation, and interest during construction. The facilities and costs are the same as the PFR Initial Action Alternative WSFQ (Reclamation, 2008a). The cost estimate includes construction costs ($3.03 billion) and interest during construction ($0.59 billion). Project cost estimates are based on feasibility-level engineering designs for the various facilities, but costs are subject to change as the feasibility study progresses.

Example Sites Reservoir Project Formulation Operations

Operational priorities of the example Sites Reservoir project formulation are to improve both the water quality and the reliability of water supplies to SWP and CVP contractors; to provide long-term water supplies to support fish restoration actions; to improve the water supply reliability for wildlife refuges; and improve Delta water quality for water users and ecosystems and habitat. Operations of the reservoir would be fully integrated with the operation of the CVP and SWP systems to provide the array of benefits described later in this Chapter, as well as ensure that local conveyance and operations are respected.

The example Sites Reservoir project formulation would be operated to improve Delta water quality. Generally, water quality in the Delta diminishes over the summer and into the fall as inflow to the Delta decreases. Sites Reservoir could release up to 1,500 cfs through the Delevan Pipeline to the Sacramento River to improve Delta water quality. Improved water quality in the Delta is a benefit to both agricultural and urban users and to certain ecosystem functions. For example, conditions may be improved for Delta smelt by maintaining the location of the saltwater/freshwater interface further downstream in the Delta during specific periods.

Table 3-1. Summary of the Example Sites Reservoir Project Features

Project Feature	Details
Sites Reservoir	Gross Storage Capacity – 1.8 MAF Maximum Water Surface Elevation – 520 feet msl Minimum Operating Pool – 320 feet msl Inundation Area – 14,000 acres
Golden Gate Dam (Sites Reservoir)	Location – Funks Creek Earth Rockfill Embankment Dam Maximum Height – 310 feet
Sites Dam (Sites Reservoir)	Location – Stone Corral Creek Earth Rockfill Embankment Dam Maximum Height – 290 feet
9 Saddle Dams (Sites Reservoir)	Location - North end from Funks Creek to Hunters Creek Earth Rockfill Embankment Dams Dams 1, 2, 4, 9 – 40 to 50 feet high Dams 3, 5, 6, 7, 8 – 70 to 130 feet high
Emergency Spillway (Sites Reservoir)	Location – Saddle Dam 4
Sites Pumping/Generating Plant	Location – Downstream from Golden Gate Dam Pumping Capacity – 5,900 cfs Generating Capacity – 5,100 cfs
Funks Reservoir	Active Storage Volume – 3,800 AF
GCID Canal Fish Screens	Maximum Operating Flow – 150,000 cfs
GCID Canal	Existing Capacity to Terminal Regulating Reservoir (With Minor Reshaping) – 1,800 cfs
TC Canal	Existing Capacity at Funks Reservoir – 2,100 cfs
Terminal Regulating Reservoir and Pumping/Generating Plant	Storage Volume – 2,000 AF Pumping Capacity – 1,800 cfs Generating Capacity – 1,500 cfs
New Delevan Pipeline and Pumping/Generating Plant	Would provide a new point of diversion and release to the Sacramento River Pumping Capacity – 2,000 cfs Generating Capacity – 1,500 cfs
Ecosystem Restoration Account	Improve the reliability of cold water carry-over storage at Shasta Lake Increase supplemental flows for cold water release for salmon and steelhead on the Sacramento River Reduce diversions on the Sacramento River to provide water to TC and GCID Canals during July, August, and September Improve the reliability of cold water carry-over storage at Folsom Reservoir and stabilize flows in the American River Modify spring flows into a “snowmelt pattern” in years with peak storm events in late-winter on Sacramento River to support riparian establishment Stabilize fall flows to avoid abrupt reductions in the Sacramento River that may lead to stranding
Road Relocations and Access Roads	Road alignments Additional roads
Utility Relocations	Four- or Six-Breaker Ring Configurations
Hydroelectric Facilities	Hydropower, hydroelectric facilities would be added to many of the pumping plants as feasible
Recreation Facilities	Five Recreation Areas

AF = acre-feet
cfs = cubic feet per second
GCID = Glenn-Colusa Irrigation District
MAF = million acre-feet
msl = mean sea level
TC = Tehama-Colusa

In general, the reliability of water supplies is improved by the addition of storage to the CVP and SWP systems. With an example Sites Reservoir, SWP storage releases upstream of the Delta now could be made from two locations (Lake Oroville and Sites Reservoir) rather than one. Integrated operations with the CVP could be accomplished with even more flexibility because Sites Reservoir would be effectively downstream of Shasta Lake. Sites Reservoir could also deliver water directly to the service areas immediately adjacent to the reservoir. These service areas include a number of CVP contractors and water rights holders including the Glenn-Colusa Irrigation District and the Tehama-Colusa Canal Authority contractor service areas. Today, these contractors get most of their deliveries directly from the Sacramento River. Deliveries made from Sites Reservoir into these service areas would allow much of that water to remain in storage at Shasta Lake. This additional water left in storage at Shasta could then be used to accomplish many of the remaining benefits including water supply reliability and ecosystem restoration actions.

Ecosystem restoration actions are supported by dedication of reservoir resources (especially storage) to specific environmental benefits. To facilitate restoration actions, project planners conceived of an ecosystem restoration account (ERA) as part of Sites Reservoir operations. The basis of the account is derived from related planning efforts, including the CALFED ERP, which developed an integrated systems approach based on reversing the fundamental causes of decline in fish and wildlife populations by recognizing the natural forces that created historic habitats and using these forces to help regenerate habitats. The ERP was not designed as mitigation for CALFED projects; instead, it was intended to fulfill the objectives of improving ecological processes and increasing the amount and quality of habitat, equal with other CALFED program goals related to water supply reliability, water quality, and levee system integrity.

The ERP has been accommodated in NODOS planning by dedicating a NODOS storage allocation to ERP objectives (an ERP pool or account, i.e., the ERA), and then giving resource managers the ability to adjust priorities based on the monitoring of implemented actions, as well as potential new priorities. The NODOS planning team identified ERP objectives that could be supported by implementing a NODOS project and prioritized actions with input from the Sacramento River Flow Regime Technical Advisory Group. The list of potential ERP objectives includes both tributary actions and Delta actions.

The example Sites Reservoir project formulation presented in this report includes a set of ERP/ERA actions focused on the Sacramento River, and some improvements to the Feather River, American River, Trinity River, and the Delta. These restoration actions include:

- Improve the reliability of the cold water pool at Shasta Lake to support anadromous species
- Improve the reliability of the cold water pool at Trinity Lake to support anadromous species
- Improve the reliability of the cold water pool at Lake Oroville to support anadromous species
- Improve the reliability of the cold water pool at Folsom Lake to support anadromous species
- Improve instream temperature conditions in the Sacramento River below Shasta Lake for anadromous species with supplemental releases
- Stabilize Sacramento River fall flows below Shasta Lake to avoid fish stranding and reduce dewatering of redds and egg desiccation with supplemental releases
- Reduce diversion effects to fish at existing diversions on the Sacramento River by reducing the rate of larger diversions
- Improve conditions for cottonwood establishment and riparian success adjacent to the Sacramento River with supplemental releases

- Improve the location of the saltwater/freshwater interface (i.e., location of X2) in the Delta with supplemental releases to enhance conditions for Delta smelt

In the future, restoration managers may determine that a different set of actions have priority over the existing actions included here and that ERA assets be allocated to meeting higher priority objectives.

Example Sites Reservoir Project Formulation Benefits

For the purposes of this report, a simulation of system wide operations with historic streamflow conditions (i.e., CALSIM and related models) was used to determine the change in the average and driest periods benefits provided by an example Sites Reservoir project for primary purposes, including agricultural and M&I water supply reliability, refuge supply reliability, water quality, and ecosystem restoration.

This section describes benefits the example formulation of Sites Reservoir can provide when integrated with the SWP and CVP systems. The information presented in this section is for informational purposes only. The example Sites Reservoir project formulation was formulated to achieve a wide variety of objectives and may not represent the most technically and/or economically feasible alternative considered in past and/or future feasibility study reports and environmental documentation; therefore, it should not be considered as a preferred alternative.

A summary of the Sites Reservoir estimated benefits (yield) is provided in Table 3-2. However, as will be discussed in later sections, the volumes of water associated with ecosystem restoration actions with Sites Reservoir is much higher than the total yield shown in Table 3-2 because a specific amount of water can be used for multiple purposes. Benefits are allocated to ecosystem restoration, water supply reliability, and water quality categories. Long-term benefits for each of the beneficiary categories are equally distributed. The driest periods average benefit can be understood as drought benefit; this benefit is based upon the three historic statewide droughts from 1928-1934, 1976-1977, and 1986-1992. The importance of project performance during a statewide drought is discussed in Chapter 2.

Table 3-2. Summary of Potential Benefits (Yield) of the Example Sites Reservoir Project Formulation

Potential Beneficiary	NODOS Delivered Water Benefits (TAF/year)	
	Long-Term Average[1]	Driest Periods Average[2]
Ecosystem Restoration	180	66
Water Supply Reliability	183	209
Water Quality	197	112
Total	560	387

TAF = thousand acre feet

Notes:
1 Long-term average is the average water supply for the period October 1922 to September 2003.
2 Driest periods average is the average water supply for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

The following sections describe how the example Sites Reservoir project formulation would meet project objectives and achieve project benefits, including public benefits. This analysis presents Sites Reservoir project performance with current infrastructure and Delta operations, including actions identified in the 2008/2009 BOs. The presentation distinguishes between public benefits and non-public benefits based upon guidance from the 2009 Comprehensive Water Package. Potential benefits are illustrated on Figure 3-4.

Public Benefits

According to the 2009 Comprehensive Water Package, public benefits may include ecosystem restoration, water quality improvements, flood control benefits, emergency response, and recreation. Public benefits provided by the example project formulation include ecosystem improvements, flood control benefits, emergency response, and recreation. Water quality improvements for the environment would be achieved, but in this presentation all water quality benefits are discussed in the context of improved exported water quality and ecosystem improvements for simplicity. For this Progress Report, it was assumed that water supply reliability and water quality benefits for M&I and agricultural water users and hydropower/flexible generation are non-public benefits and would be paid for by users.

Ecosystem Improvements

It is challenging to report ecosystem restoration benefits in a manner that is easily understood. Therefore, the change in releases to Delta outflow that occur as a result of ecosystem restoration actions is reported in Table 3-2 to give a better sense of comparison with the other water release benefits, such as water supply reliability and water quality. This is intended to provide a conservative estimate of "yield" associated with the restoration actions supported by the Sites Reservoir ERA. Table 3-3 provides common physical and statistical measures of ecosystem restoration actions. An additional summary of restoration action volumes that occur as a result of the ERA actions is shown in Table 3-4 to provide a more complete picture of the quantities of water associated with these restoration actions. This water volume summary table depicts how efficiently new storage adjacent to the Sacramento River can move water around within the CVP and SWP systems. For example, many of these restoration actions are provided with the same water used two or three times and water may also be used for a restoration action upstream and then used for a water quality or water supply benefit downstream.

Temperature improvements in the rivers below large system reservoirs can be achieved two ways. First, retaining additional water in a reservoir at the end of the water year (September 30) improves the "cold water pool" of that reservoir. Water in near empty reservoirs warms rapidly. The performance measures shown in Table 3-3 reflect the reliability of the cold water pools at four CVP and SWP reservoirs. For example, the target storage for cold water pool maintenance at Shasta Lake is 2.2 MAF. With an example Sites Reservoir, the 2.2 MAF end-of-September target storage in Shasta Lake is achieved 84.1% of the time, 3.7% more often than without it. Second, increasing releases from a reservoir lowers river temperatures. The temperature improvements shown for the Sacramento River are a result of both actions: improved cold water pool and supplemental releases to achieve temperature targets. Cooler temperature is especially critical for anadromous species during dry or drought conditions. Therefore, the greater temperature improvements shown for driest periods (-1.4°F) compared to average (-0.4°F) is a desirable result.

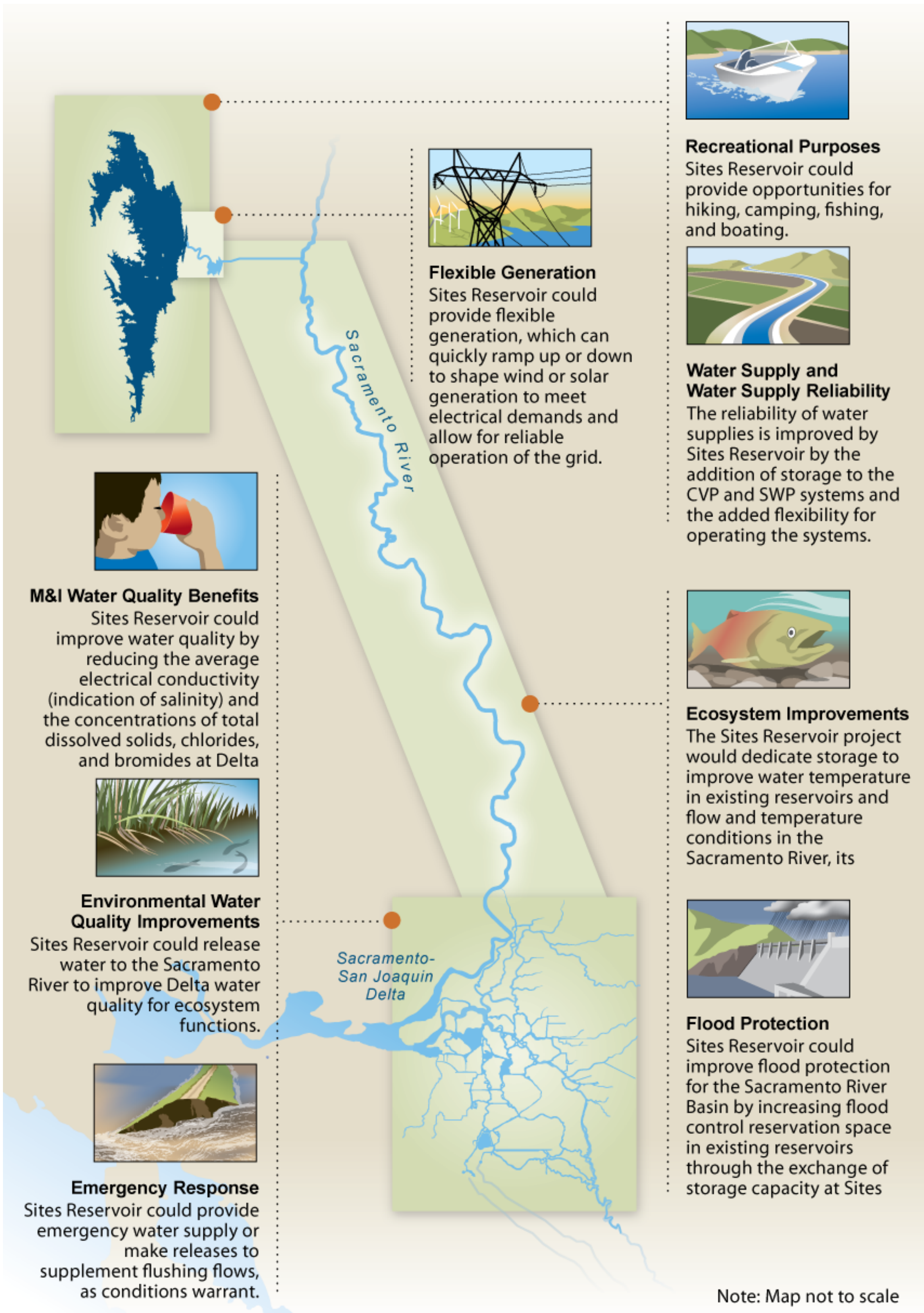

Figure 3-4. Summary of Potential Benefits of the Example Sites Reservoir Project

Each of the restoration actions listed in Table 3-4 has an associated volume of water, either a supplemental flow, a reduced diversion amount, or additional water in storage. The long-term average yield associated with restoration actions, 180 thousand acre-feet (TAF) (from Table 3-2), results in 666 TAF of restoration actions occurring at different locations throughout the Delta and related watersheds. While the yield associated with restoration actions diminishes significantly during driest periods, the volume of water resulting from the various restoration actions increases dramatically. During drought years, 66 TAF of restoration "yield" (Table 3-2) achieves 832 TAF of actions (Table 3-4) throughout the state's river systems and Delta. This improvement in restoration action efficiency is due in part to the conservative estimate of restoration action yield used for this report. Also, the system is much more efficient during drought periods. Water associated with a restoration action upstream is more likely to be used again before flowing out from the Delta. In that case, the water would not be accounted as ecosystem restoration "yield" in summary Table 3-2. However, all quantities of water associated with restoration actions are included in the water volume summary Table 3-4.

In addition to the ERA objectives, this example Sites Reservoir formulation also includes the following features to improve aquatic habitat conditions:

- Reclaiming inactive gravel mining sites along the Sacramento River near the Primary Study Area to create valuable aquatic and floodplain habitat
- Replenishing gravel suitable for spawning in the Sacramento River
- Improving instream aquatic habitat to help provide favorable spawning conditions
- Improving adjacent shoreline habitat

Specific benefits associated with these actions that do not require additional water have not yet been quantified.

Table 3-3. Physical and Statistical Measures of Ecosystem Restoration Benefits of the Example Sites Reservoir Project Formulation

Potential Anadromous or Ecosystem Restoration Action/Target	Potential Physical and Statistical Measure Benefits	
	Long-Term Average[1]	Driest Periods Average[2]
Change in peak summer monthly upstream temperatures (°F) in the Sacramento River at Bend Bridge below Shasta Lake with supplemental releases	-0.4	-1.4
Shasta Lake performance measure [% of years with end of September storage greater than 2.2 MAF (% improvement)]	84.1 (+3.7)	NA
Lake Oroville performance measure [% of years with end of September storage greater than 1.1 MAF (% improvement)]	90.2 (+9.8)	NA
Folsom Lake performance measure [% of years with end of September storage greater than 300 TAF (% improvement)]	92.7 (+3.7)	NA
Trinity Lake performance measure [% of years with end of September storage greater than 600 TAF (% improvement)]	97.6 (+6.1)	NA

°F = degrees Fahrenheit NA = not applicable
MAF = million acre feet TAF = thousand acre feet

Notes: [1] Long-term average is the average for the period October 1922 to September 2003.

[2] Driest periods average is the average for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

Table 3-4. Volumes of Water Associated with Ecosystem Restoration Actions of the Example Sites Reservoir Project Formulation

Potential Anadromous or Ecosystem Restoration Action/Target	Volume of Water Associated with Restoration Action (TAF/year)	
	Long-Term Average[1]	Driest Periods Average[2]
Stabilize Fall flows in the Sacramento River below Keswick (October-November) to prevent redd dewatering	218	88
Provide Spring flows for Cottonwood/Willow establishment in the Sacramento River (March-April)	51 (528 TAF/event) (8 events)	NA
Reduce TCCA/GCID diversions from the Sacramento River (April-October) to protect fish migration [total TAF/season associated with reduced diversion]	236	224
Shasta Lake cold water pool improvement	-20	271
Lake Oroville cold water pool improvement	165	134
Folsom Lake cold water pool improvement	20	42
Trinity Lake cold water pool improvement	-4	73
Additional releases to support March Delta outflow, May Freeport flow, and Yolo Bypass flow	NA	NA
Total volume of water associated with ERA ecosystem actions	666	832

ERA = ecosystem restoration account
GCID = Glenn-Colusa Irrigation District
MAF = million acre feet
NA = not applicable
TAF = thousand acre feet
TCCA = Tehama-Colusa Canal Authority

Notes:
1 Long-term average is the average for the period October 1922 to September 2003.
2 Driest periods average is the average for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

Flood Control Benefits/Flood Protection

Diversions from the Sacramento River would not be large enough to reduce peak flows significantly, based on previous analysis of alternatives presented in the NODOS PFR; however, Sites Reservoir could improve flood protection for the Sacramento River Basin by increasing flood control reservation space in existing reservoirs through the exchange of storage capacity at Sites Reservoir. Through coordinated operations with SWP and CVP and other flood control reservoirs and accurate forecasting, water could be held in Sites Reservoir in-lieu of water in other reservoirs to create flood control storage space in the other reservoirs. New analyses on flood damage reduction opportunities at the example Sites Reservoir project formulation were not conducted for this report. These analyses will be included in the feasibility study efforts.

Emergency Response/Storage

New analyses on emergency response opportunities at the example Sites Reservoir project formulation were not conducted for this report. These analyses will be included in the feasibility study efforts. However, the Sites Reservoir alternatives that include a Delevan Pipeline with a 1,500-cfs release capacity could provide some flushing flows (to prevent saltwater intrusion) through the Delta in the event of catastrophic levee failures within the Delta. Although this would not be a large release, the proximity of Sites Reservoir to the Delta would make this an important feature because of the improved response time (flows would reach the Delta faster than they would from existing upstream reservoirs).

Recreational Purposes

New analyses on recreation opportunities at the example Sites Reservoir project formulation were not conducted for this report, but will be included in the Feasibility Report. However, Sites Reservoir could provide opportunities for hiking and camping and limited opportunities for fishing and boating. Sites Reservoir has the potential to affect flatwater, or reservoir-based, recreation at the reservoir itself and at Shasta Lake, Lake Oroville, and Folsom Lake. Operating strategies at Sites Reservoir would be employed to mitigate any impacts to recreation at Shasta Lake, Lake Oroville, and Folsom Lake (these impacts are not expected to be adverse and should be generally beneficial).

Water Supply Reliability Benefits

Following is a list of general water supply and water supply reliability needs that could be met directly by a potential NODOS project:

- Agricultural Water Supply Reliability
    - Local agricultural water districts
    - SWP contractors
    - CVP contractors
- M&I Water Supply Reliability
    - CVP contractors
    - SWP contractors
- Environmental Water Supply Reliability (this would be considered a public benefit)
    - Sacramento and San Joaquin Valleys Level 4 Refuge water supply

All water supply reliability benefits are shown in Table 3-2. Although included in Table 3-2 as water supply reliability, refuge water supply would likely be considered a public benefit. The drought yield for agricultural, M&I, and refuge water supply deliveries, is 209 TAF and the long-term average yield is 183 TAF. Weighting delivery priorities toward drought periods is accomplished by carrying over additional water in reservoirs from year to year. Specifically, water is retained in storage for use during dry or drought conditions. This operational approach could be modified to increase average water supply, which would result in a corresponding decrease in driest period water supply. Increased average year supply may be desirable for some water users.

M&I Water Quality Benefits

An example Sites Reservoir project could improve water quality by reducing the average electrical conductivity (indication of salinity) and the concentrations of total dissolved solids (TDS), chlorides, and bromides in deliveries from the Delta. For illustrative purposes, reductions in TDS at Banks Pumping Plant were modeled for the example Sites Reservoir project formulation (Table 3-5).

Water quality improvements may also benefit ecosystem and habitat conditions in the Delta and may qualify as a public benefit. For simplicity, all water quality benefits were considered non-public for this report.

Table 3-5. Potential Reductions in TDS at Banks Pumping Plant Due to the Example Sites Reservoir Project Formulation

Potential Water Quality Benefit	Potential Benefit	
	Long-Term Average[1]	Driest Periods Average[2]
Change in TDS exported at Banks Pumping Plant (mg/L)	-10.9	-3.1

mg/L = milligrams per liter TDS = total dissolved solids

Notes: [1] Long-term average is the average for the period October 1922 to September 2003.

[2] Driest periods average is the average for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

Hydropower/Flexible Generation

Hydropower generation facilities in the example Sites Reservoir project formulation include the Sites Pumping/Generating plant between the main reservoir and Funks Reservoir, the Terminal Regulating Reservoir (TRR) Pumping/Generating plant between Funks Reservoir and the TRR, and the Delevan Pumping/Generating plant between Funks Reservoir and the Sacramento River. A potential Sites Reservoir also could have the capability to pump-back water at the Sites Pumping/Generating plant during standby or low operation times. Detailed analysis will be conducted as part of the feasibility study. Sites Reservoir could provide ancillary services to the statewide grid such as non-spin or regulation down which could aid in maintaining the electric system reliability and system frequency. Additionally, Sites Reservoir could provide shaping/firming power to allow the statewide grid to maintain electric system reliability and system frequency as more power is provided by non-dispatchable, intermittent wind and solar generation. These analyses will be completed in the draft Feasibility Report and EIS/EIR.

Based on information provided in the NODOS PFR, the initial Sites Reservoir alternatives are not intended to contribute a large supply of additional power to the statewide grid. A potential Sites Reservoir project would be, however, capable of adding power to the statewide grid during critical times of the year.

Example Sites Reservoir Project Formulation Benefits Under an Uncertain Future

As stated previously in this report, future conditions are uncertain at this time and considered projects must be able to fulfill project objectives and provide benefits under variable future conditions. This section describes new modeling conducted and presents new information on how an example Sites Reservoir project formulation could be coordinated with potential new Delta conveyance. The section also presents qualitative analysis on the potential of climate change to impact Sites Reservoir's ability to achieve project objectives. The information presented in this section is for informational purposes only.

Potential Effect of New Delta Conveyance on Project Benefits

Integration with new Delta conveyance would alter the operations of Sites Reservoir from those discussed previously in regards to water quality and ecosystem restoration actions. The relative value of improving Delta water quality diminishes with new conveyance in the Delta. The diversion of water from the lower Sacramento River associated with new Delta conveyance will significantly improve the quality of diverted water. Therefore, in this analysis a Delta water quality benefit is not shown for operations that include new Delta conveyance.

The performance of the NODOS ecosystem restoration actions varies with potential future conditions. Since the Delta water quality benefit is diminished with new Delta conveyance, the list of ERA actions would be larger under scenarios that include new Delta conveyance because more water would be available to dedicate to ERA actions. Therefore, ERA actions supported by the example Sites Reservoir formulation with new Delta conveyance include:

- All of the actions identified in the operation section with existing Delta conveyance
- Improve March Delta outflow with supplemental releases
- Increase May Freeport flows with supplemental releases
- Support flows through Yolo Bypass with supplemental releases

The results of analyses to evaluate the performance of the example Sites Reservoir project formulation with new Delta conveyance integrated with the CVP and SWP systems and the summary of benefits is displayed in Table 3-6. As noted previously, water quality benefits are assumed to be diminished with new Delta conveyance. Since the formulation with new Delta conveyance only supports two types of benefits, those average benefits (ecosystem restoration and water supply reliability) are greater.

Table 3-6. Summary of Potential Benefits (Yield) of the Example Sites Reservoir Project Formulation with New Delta Conveyance

Beneficiary	NODOS Delivered Water Benefits (yield) With New Delta Conveyance (TAF/year)	
	Long-Term Average[1]	Driest Periods Average[2]
Ecosystem Restoration	272	91
Water Supply Reliability	204	147
Water Quality	NM	NM
Total	476	238

NM = not modeled as a NODOS objective

TAF = thousand acre feet

Notes: [1] Long-term average is the average for the period October 1922 to September 2003.

[2] Driest periods average is the average for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

The following sections present how an example Sites Reservoir project formulation could accomplish project objectives and provide benefits under future operation scenarios that include potential new Delta conveyance, as being studied by the Bay-Delta Conservation Plan and Delta Habitat Conservation and Conveyance Program. The sections focus on analysis conducted for ecosystem improvements and water quality. Other benefit categories discussed previously that are not expected to change significantly with new Delta conveyance are not discussed again in this section; however, further analysis will be conducted as the feasibility study progresses.

Ecosystem Improvements

Table 3-7 shows the physical and statistical measures of ecosystem restoration benefits of Sites Reservoir implementation with new Delta conveyance. These benefits are generally similar with new Delta conveyance. The cold water pool improvements are generally less with the exception of Shasta Lake, which remains the same. Temperature improvements are slightly better with new Delta conveyance.

Table 3-7. Physical and Statistical Measures of Ecosystem Restoration Benefits of the Example Sites Reservoir Project Formulation with New Delta Conveyance

Potential Anadromous or Ecosystem Restoration Action/Target	Physical and Statistical Measure Benefits with New Delta Conveyance	
	Long-Term Average[1]	Driest Periods Average[2]
Change in peak summer monthly upstream temperatures (°F) in the Sacramento River at Bend Bridge below Shasta Lake with supplemental releases	-0.8	-1.5
Shasta Lake performance measure [% of years with end of September storage greater than 2.2 MAF(% improvement)]	86.6 (+3.7)	NA
Lake Oroville performance measure [% of years with end of September storage greater than 1.1 MAF(% improvement)]	92.7 (+7.3)	NA
Folsom Lake performance measure [% of years with end of September storage greater than 300 TAF(% improvement)]	90.2 (+0)	NA
Trinity Lake performance measure [% of years with end of September storage greater than 600 TAF(% improvement)]	97.6 (+2.4)	NA

°F = degrees Fahrenheit MAF = million acre feet
NA = not applicable TAF = thousand acre feet
Notes: [1] Long-term average is the average for the period October 1922 to September 2003.
[2] Driest periods average is the average for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

The volumes of water associated with the ecosystem restoration actions supported by Sites Reservoir are shown in Table 3-8. The total volume of water with Sites Reservoir and new Delta conveyance are greater for long-term average, but lesser during drought. The volumes of additional water associated with the cold water pools at the reservoirs seem to be most affected by adding new Delta conveyance.

Table 3-8. Volumes of Water Associated with Ecosystem Restoration Actions of the Example Sites Reservoir Project Formulation with New Delta Conveyance

Potential Anadromous or Ecosystem Restoration Action/Target	Volume of Water Associated with Restoration Action (TAF/year)	
	Long-Term Average[1]	Driest Periods Average[2]
Stabilize Fall flows in the Sacramento River below Keswick (October-November) to prevent red dewatering	227	127
Provide Spring flows for Cottonwood/Willow establishment in the Sacramento River (March-April)	51 (533 TAF/event) (8 events)	NA
Reduce TCCA/GCID diversions from the Sacramento River (April-October) to protect fish migration [total TAF/season]	301	276
Shasta Lake cold water pool improvement	29	136
Lake Oroville cold water pool improvement	141	130
Folsom Lake cold water pool improvement	16	4
Trinity Lake cold water pool improvement	-4	17
Additional releases to support March Delta outflow, May Freeport flow, and Yolo Bypass flow	93	5
Total volume of water associated with ERA ecosystem actions	854	695

ERA = ecosystem restoration account GCID = Glenn-Colusa Irrigation District
NA = not applicable TAF = thousand acre feet
TCCA = Tehama-Colusa Canal Authority
Notes: [1] Long-term average is the average for the period October 1922 to September 2003.
[2] Driest periods average is the average for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

Water Quality Improvements

As shown in Table 3-9, there is some improvement in TDS with the example Sites Reservoir project and new Delta conveyance, but the need for improvement is likely less significant due to water quality improvements provided by new Delta conveyance alone.

Table 3-9. Potential Reductions in TDS at Banks Pumping Plant Due to the Example Sites Reservoir Project Formulation with New Delta Conveyance

Potential Water Quality Benefit	Potential Benefit	
	Long-Term Average[1]	Driest Periods Average[2]
Change in TDS export at Banks Pumping Plant (mg/L)	-4.8	-1.1

mg/L = milligrams per liter
TDS = total dissolved solids
Notes: [1] Long-term average is the average for the period October 1922 to September 2003.
[2] Driest periods average is the average for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

Potential Effect of Climate Change on Project Benefits

As noted in Chapter 2, Water Management Issues and Challenges, climate change effects upon California's water resources are already being observed and are anticipated to increase over time. The following qualitative discussion of climate change effects to the operation of Sites Reservoir are intended to provide the types of effects that are anticipated to occur. As part of the feasibility study, the NODOS Investigation plans to provide a more detailed analysis of climate change effects. An operations simulation of the example Sites Reservoir project formulation with climate change was not included in this study effort. However, previous simulations of a similar formulation and future conditions with climate change inform this report.

A number of climate change effects will modify either future conditions or the functional capability of Sites Reservoir:

- Sea level rise will require more water from upstream reservoirs to maintain water quality in the Delta
- Carryover storage at system reservoirs will be diminished significantly and is related in part to the additional water required to repel salinity in the Delta, causing both system vulnerabilities and local adverse effects
- Higher temperatures will decrease Sierra snowpack storage, changing runoff timing, intensity, and duration
- Unmet demands will increase

The specific effects to the example Sites Reservoir operations and benefits are not quantified here. Generally, the greatest effect will likely be an increase in unmet demand associated with the factors described above.

Sites Reservoir Potential Environmental Effects

Primary potential effects for aquatic biological, terrestrial biological, and cultural resources affected by an example Sites Reservoir are described in the PFR. Examples of potential adverse effects described in the PFR include inundation of terrestrial habitats and associated species and inundation of cultural resources sites. Potential beneficial effects, such as improved habitat and flow conditions in the Sacramento River and improved recreation opportunities, are also described in the PFR.

Additional environmental analyses will be completed during the feasibility study which will inform the nature of potential mitigation and/or enhancement measures included in Sites Reservoir alternative plans, and included in the Draft and Final Feasibility Report and accompanying EIS/EIR. Construction of a new reservoir at Sites would be subject to the requirements of numerous federal, state, and local laws, policies, and regulations. Reclamation is the lead agency for National Environmental Policy Act (NEPA) compliance, and DWR is the lead agency for California Environmental Quality Act (CEQA) compliance. Moreover, DWR and Reclamation would need to obtain various permits and meet regulatory requirements before beginning any project construction, and comply with a number of environmental regulatory requirements as part of the NEPA and CEQA compliance process.

A draft EIS/EIR disclosing environmental effects resulting from the NODOS Investigation is scheduled for release in 2011. Environmental studies and evaluations are currently being conducted to determine the type and extent of potential environmental impacts. It is anticipated that some of the adverse effects would be temporary, construction related effects and other adverse effects would be permanent, such as effects on botanical and wildlife resources within the newly inundated areas. As part of the project planning and environmental assessment process, DWR and Reclamation will incorporate environmental commitments and best management practices to avoid or minimize potential effects. DWR and Reclamation have also committed to coordinate with applicable resource agencies and tribal groups during planning, engineering, design, construction, operation, and maintenance phases of the project. The Feasibility Report and EIS/EIR will also include a greenhouse gas emission analysis and a sensitivity analysis evaluating the potential effects of climate change on the project.

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Chapter 4 Upper San Joaquin River Basin Storage Investigation

This section describes the initial phases of the feasibility study of potential storage projects in the upper San Joaquin River watershed to expand water storage capacity; improve water supply reliability and operational flexibility of the water management system for agricultural, urban, and environmental uses; and enhance San Joaquin River water temperature and flow conditions to support anadromous fish restoration efforts. This section also summarizes new information for the Upper San Joaquin River Basin Storage Investigation (USJRBSI) (See Box 4-1 for a list of acronyms and abbreviations used in this section) reflecting recent water management changes including the 2008 US Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) Biological Opinions (BO) and how new surface storage in the upper San Joaquin River watershed could be coordinated with other water resource management activities (e.g., new project baselines and new conveyance in the Sacramento-San Joaquin Delta [Delta]).

Study Area

The primary study area (Figure 4-1) encompasses the San Joaquin River watershed upstream from Friant Dam to Kerckhoff Dam, including Millerton Lake, and areas that would be directly affected by construction activities, including the footprint of reservoir alternatives and related facilities upstream from Friant Dam. Friant Dam and Millerton Lake are on the San Joaquin River about 20 miles northeast of Fresno. Millerton Lake has a total storage capacity of approximately 520 thousand acre-feet (TAF), an active storage capacity of approximately 390 TAF, and an average annual inflow of approximately 1.8 million acre-feet (MAF). Friant Dam diverts much of the water from the San Joaquin River to the eastern portions of the San Joaquin and Tulare Lake hydrologic regions, from Chowchilla in the north to Bakersfield in the south.

The extended study area encompasses locations of potential project features and areas potentially affected by alternatives implementation and/or operations. These include the upper San Joaquin River watershed, the San Joaquin River downstream from Friant Dam, the Delta, lands with San Joaquin River water rights, and water service areas in the Friant Division and south-of-Delta (SOD) Central Valley Project (CVP) and State Water Project (SWP).

Project Objectives

Major water and related resources problems and needs for the USJRBSI pertain to water supply reliability and the San Joaquin River ecosystem. Opportunities also have been identified during the investigation, as described below. The problems, needs, and opportunities in the primary and extended study areas served as the basis for the planning objectives. This section briefly summarizes the problems, needs, and opportunities for the USJRBSI and presents planning objectives.

Water Supply Reliability

Major factors affecting California's future water supplies include rapid population growth; agricultural-to-urban land use conversion; and climate change and related uncertainties, including Delta infrastructure, operations criteria, and ecosystem conditions. The California Water Plan Update 2005 states that California must invest in reliable, high-quality, sustainable and affordable water conservation; efficient water management; and development of water supplies.

The Friant Division of the CVP provides surface water supplies to many areas that also rely on groundwater, and was designed and is operated to support conjunctive water management to reduce groundwater overdraft in the eastern San Joaquin Valley. Although surface water deliveries from Friant Dam help reduce groundwater pumping and contribute to groundwater recharge, the groundwater basins in the eastern San Joaquin Valley remain in a state of overdraft in most years, which may ultimately reduce water use and irrigated acreage in the San Joaquin Valley.

Box 4-1. Chapter 4 Acronym and Abbreviation List

BO	Biological Opinion
CALFED	Bay-Delta Program
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
DWR	Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
IAIR	Initial Alternatives Information Report
M&I	municipal and industrial
MAF	million acre-feet
msl	mean sea level
MW	megawatt
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NRDC	Natural Resources Defense Council
PFR	Plan Formulation Report
Reclamation	United States Bureau of Reclamation
RM	River Mile
Settlement	Stipulation of Settlement
SJRRP	San Joaquin River Restoration Program
SLIS	selective level intake structure
SOD	south-of-Delta
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
USFWS	United States Fish and Wildlife Service
USJRBSI	Upper San Joaquin River Basin Storage Investigation
WRC	Water Resources Council

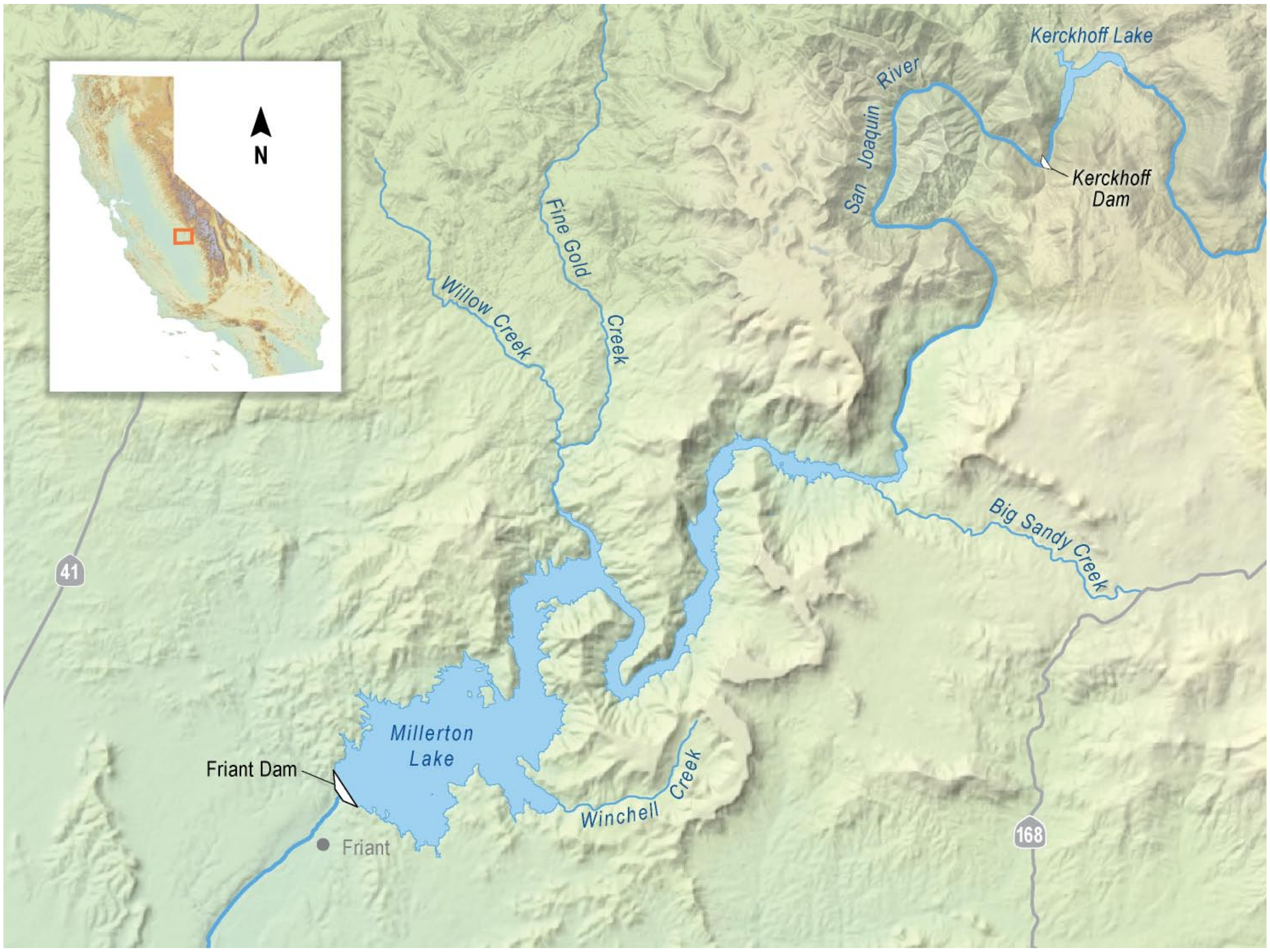

Figure 4-1. USJRBSI Primary Study Area

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and CVP Friant Division contractors. After more than 18 years of litigation of this lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, a Stipulation of Settlement (Settlement) was reached. Through implementation of the Settlement, average total system water deliveries from Friant Dam are expected to be reduced by approximately 200 TAF per year, or approximately 15% to 19% of deliveries under pre-Settlement conditions. The Water Management Goal of the Settlement is to reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim and Restoration flows provided for in the Settlement. USJRBSI storage alternatives are not associated with the Water Management Goal.

In the 1990s, protective actions, including the Central Valley Project Improvement Act and the *Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (SWRCB, 1995), reduced the ability of the SWP and CVP to contribute to statewide water supply reliability. The

CALFED Bay-Delta Program (CALFED) estimated that these two protective actions reduced water contract deliveries by more than 1 MAF annually during dry periods. More recently, the 2008/2009 BOs for delta smelt and salmon further reduced the annual delivery capability of the SWP and CVP.

San Joaquin River Ecosystem

Generally unhealthy ecosystem conditions in the San Joaquin River from Friant Dam to the Merced River have resulted from lack of reliable flows and poor water quality. The Settlement led to the inclusion of Settlement-stipulated releases from Friant Dam for river restoration as a without-project condition for the USJRBSI. The Restoration Goal of the Settlement is to provide continuous flows in the San Joaquin River at Friant Dam to sustain naturally reproducing Chinook salmon and other fish populations in the river. The ability to manage volumes of cold water and to release water from Friant Dam at suitable temperatures, and provide for Settlement flows during critical-low years, may be challenges to fully meeting the Restoration Goal of the Settlement.

Opportunities

Identified opportunities include potential improvement in the reduction of flood damages; additional hydropower/flexible generation capacity; recreation site development and water level management; and water quality improvements in the San Joaquin River and in water supplies delivered to urban areas.

Planning Objectives

On the basis of the identified water and related resources problems, needs, and opportunities, study authorizations, and other pertinent direction, including information contained in the August 2000 CALFED Record of Decision, the following planning objectives for the USJRBSI were developed:

Primary Planning Objectives

- Increase water supply reliability and system operational flexibility for agricultural, municipal and industrial (M&I), and environmental purposes in the Friant Division, other San Joaquin Valley areas, and other regions
- Enhance water temperature and flow conditions in the San Joaquin River from Friant Dam to the Merced River in support of restoring and maintaining naturally reproducing and self-sustaining anadromous fish (i.e., Settlement reintroduced fall- and/or spring-run Chinook salmon)

Secondary Planning Objectives

- Improve management of flood flows at Friant Dam
- Provide flexible generation allowing for the integration of renewable generation into the electric grid, preservation of energy generation, and improved energy management
- Preserve and increase recreation opportunities in the study area
- Improve San Joaquin River water quality
- Improve the quality of water supplies delivered to urban areas

Project Formulation and Initial Alternatives

The first interim planning document, the Phase 1 Investigation Report, completed in October 2003 (Reclamation and DWR, 2003), identified and addressed 17 possible reservoir sites in the eastern San

Joaquin Valley and selected 6 for continued study. Nearly all six retained sites are located in the upper San Joaquin River basin. In February 2004, formal initiation of environmental compliance processes began, in accordance with federal and state regulations, and will continue through completion of all study requirements.

The second interim planning document, the Initial Alternatives Information Report (IAIR), was completed in June 2005 (Reclamation, 2005a). It evaluated the six reservoir sites retained from Phase 1, and other reservoir storage sites added in response to comments received during public scoping, and identified potential groundwater storage measures. Twenty-four reservoir measures (based on location and size), many with multiple alternative hydropower generation options, were evaluated in the IAIR. The evaluations considered construction cost, potential new water supply that could be developed, hydropower impacts, potential replacement power generation, and preliminary environmental impacts. In addition, several initial water operations scenarios that could address various planning objectives were identified and evaluated at a preliminary level of detail. The IAIR recommended continued study of three reservoir sites as well as enlargement of Millerton Lake in combination with one of the three reservoir sites that, when combined with various reservoir sizes, facilities, and sets of operating rules and environmental measures, constitute initial alternatives.

The Plan Formulation Report (PFR) provided detailed evaluation of the initial alternatives retained from the IAIR (Reclamation, 2008b). For each initial alternative plan, several configurations were formulated to assess the incremental costs and benefits that would result from additional storage, reservoir operations, multiple reservoir elevations, and water temperature management, where relevant. Surface storage locations and reservoir sizes were evaluated in a two-step process. The first step evaluation was based on technical evaluations performed during initial plan formulation for incremental cost effectiveness at a range of potential sizes. The second step evaluation was based on the relative ability of the surface water storage alternatives to meet each of the four criteria, effectiveness, efficiency, acceptability, and completeness, from the federal planning guide *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC, 1983).

Based on this two step analysis, a 1,260 TAF reservoir at Temperance Flat at River Mile (RM) 274 and a 690 TAF reservoir at Temperance Flat at RM 279 were retained for further evaluation in the PFR. Additionally, measures to increase transvalley conveyance capacity were added to some of the alternative plans.

Four action alternative plans, in addition to the No-Action/No-Project Alternative, were addressed in detail in the PFR, including the two reservoir sites for Temperance Flat Reservoir (RM 274 and RM 279) and potential transvalley conveyance to facilitate exchanges between the Friant Division and the South-of-Delta CVP and SWP system:

- **Temperance Flat RM 274 Reservoir –** Temperance Flat RM 274 Reservoir would be formed by a dam in the upstream portion of Millerton Lake at RM 274, and would provide about 1,260 TAF of additional storage.
- **Temperance Flat RM 274 Reservoir and Increased Transvalley Conveyance Capacity –** This grouping of alternative plans included Temperance Flat RM 274 Reservoir with an increased transvalley conveyance capacity through construction of additional conveyance facilities.

- **Temperance Flat RM 279 Reservoir –** Temperance Flat RM 279 Reservoir would be formed by a dam in the upstream portion of Millerton Lake at RM 279, and would provide about 690 TAF of additional storage.
- **Temperance Flat RM 279 Reservoir and Increased Transvalley Conveyance Capacity –** This grouping of alternative plans included Temperance Flat RM 279 Reservoir with an increased transvalley conveyance capacity through construction of additional conveyance facilities.

All action alternative plans included water temperature management measures on the main dam and temperature control devices on Friant Dam. The alternative plans also included features to mitigate the loss of generation from the Kerckhoff Project powerhouses. The action alternative plans were evaluated under several distinct operations scenarios, which varied according to the extent of operations integration, available existing transvalley conveyance, and reservoir balancing. The primary operational focus was increasing water supply reliability and enhancing water temperature conditions in the San Joaquin River.

The No Action/No Project Alternative and the four alternatives plans, including various operational strategies, were evaluated to determine their accomplishment of project objectives, project benefits, and project costs. Estimates for benefits and costs used in the PFR were preliminary and subject to further refinement, but were considered sufficient to compare projects and alternative plans. Based on the analysis of accomplishments, benefits, and costs and comparison of alternative plans using the four federal evaluation criteria, the Temperance Flat RM 274 grouping of alternative plans was selected for further evaluation in the Feasibility Report and Environmental Impact Statement (EIS)/Environmental Impact Report (EIR).

As with all the surface storage studies, alternative analysis and evaluation is an iterative process and as conditions change and new information becomes available previously screened or new measures and alternative plans may be developed and evaluated during the remainder of the feasibility investigation.

Example Temperance Flat RM 274 Reservoir Project Formulation Features and Costs

This section summarizes potential project features and costs for an example Temperance Flat RM 274 reservoir project formulation. The example project formulation is most similar to the Temperance Flat RM 274 alternative plan selected in the PFR for further study in the feasibility report and EIS/EIR. Facilities and costs are generally the same. However, operations have been modified to account for new regulations in the Delta.

Example Temperance Flat RM 274 Reservoir Project Formulation Project Features

Temperance Flat RM 274 Reservoir would be created through constructing a dam in the upstream portion of Millerton Lake at RM 274 (Figure 4-2). The Temperance Flat RM 274 Dam site is approximately 6.8 miles upstream from Friant Dam. Permanent features would include a main dam with an uncontrolled spillway to pass flood flows (no saddle das are required), a powerhouse to generate electricity, and outlet works for other controlled releases. Upstream and downstream cofferdams would be required for river diversion, and to keep Millerton Lake out of the construction zone. Diversion tunnels to route river flows around the construction zone would be required during construction.

Figure 4-2. Temperance Flat RM 274 Reservoir Project Location

Annual unimpaired runoff at Friant Dam from the upper San Joaquin River basin ranges from about 360 TAF to 4,600 TAF, with an average of 1,800 TAF (water years 1901-2007). Millerton Lake, at approximately 520 TAF in volume, is often undersized to adequately manage annual inflows, underscoring the need for additional storage. For example, between 1975 and 2007 flood control releases from Friant Dam total approximately 14 MAF, and flood releases were made in about two-thirds of the years.

At the top of active storage capacity (elevation 985), Temperance Flat RM 274 Reservoir would provide about 1,260 TAF of additional storage (1,331 TAF of total storage, 75 TAF of which overlap with Millerton Lake), and would have a surface area of about 5,700 acres. The reservoir would extend about 18.5 miles upstream from RM 274 to Kerckhoff Dam. Temperance Flat RM 274 Reservoir would reduce Millerton Lake storage volume and acreage at top of active storage capacity to 449 TAF and 3,890 acres, respectively.

Additional potential project features include:

- **Measures for water temperature management –** Potential water temperature management measures include a selective level intake structure (SLIS) on the main dam. A multiple-port SLIS could be constructed to improve management of the cold water pool in the reservoir for releases to Millerton Lake. The SLIS would be designed and operated to withdraw water from the highest level in the reservoir that would meet temperature targets, thereby preserving colder water at lower elevations in the reservoir. Without a SLIS, water would be drawn from the reservoir at the same elevation as the outlet works.
- **Measures to increase or maintain hydropower generation –** Temperance Flat RM 274 Reservoir would inundate the Pacific Gas and Electric Kerckhoff and Kerckhoff No. 2 powerhouses. Temperance Flat RM 274 Reservoir alternative plans include features to mitigate the loss of generation from the Kerckhoff Project powerhouses. These would involve modifying and extending the Kerckhoff No. 2 powerhouse tunnel to route water from Kerckhoff Lake to a new powerhouse and release valves downstream from Temperance Flat RM 274 Dam that would discharge into Millerton Lake. These power features are subject to change as the feasibility study progresses. Although not included in the example project formulation, flexible generation attributes of the Temperance Flat RM274 Reservoir facilities will be studied, which could be more valuable than the energy lost (especially any nighttime generation) at the Kerckhoff Project powerhouses.

Major project features of this example project formulation are illustrated in Figure 4-3 and listed below in Table 4-1.

Example Temperance Flat RM 274 Reservoir Project Formulation Potential Project Costs

As formulated in the PFR, the estimated capital cost for a new surface storage project at Temperance Flat RM 274 is approximately $3.36 billion dollars (presented in 2006 dollars) (Reclamation, 2008b). The investment cost includes construction costs ($2.9 billion) and interest during construction ($0.46 billion). Project costs are an appraisal-level cost estimate and are subject to change as the feasibility study progresses.

Example Temperance Flat RM 274 Reservoir Project Formulation Operations

As described in the PFR, a Temperance Flat RM 274 Reservoir could be operated under a variety of scenarios that could provide potential benefits for different purposes. Several operational scenarios were formulated and evaluated to assess the sensitivity of accomplishments for Temperance Flat RM 274 Reservoir to varying operational strategies and assumptions.

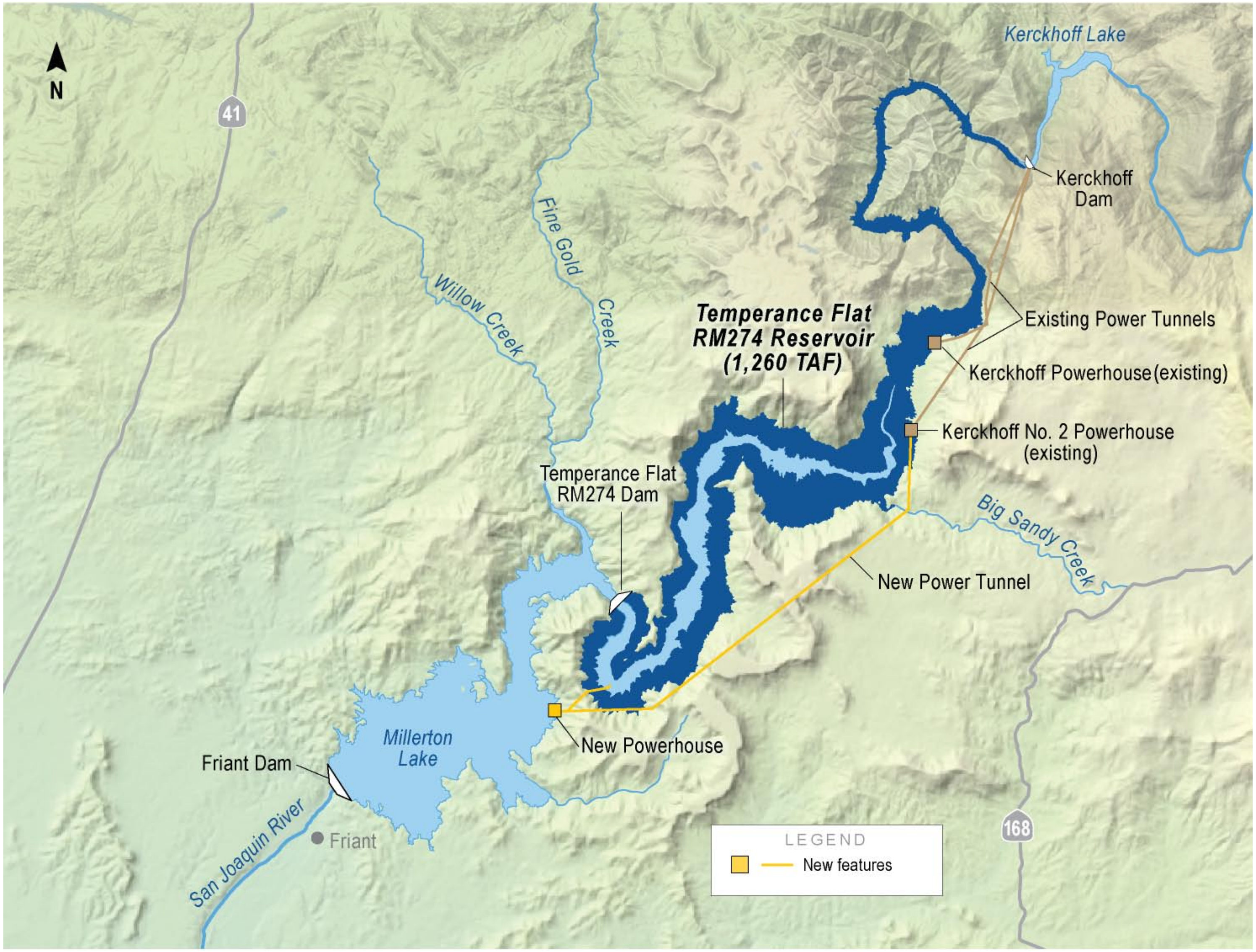

Figure 4-3. Temperance Flat RM 274 Reservoir Inundation Area and Major Project Features

Table 4-1. Summary of the Example Temperance Flat RM 274 Reservoir Project Features

Temperance Flat Reservoir	Gross Capacity - 1,330 TAF Net Capacity (Gross Capacity – Millerton Lake Overlap) - 1,260 TAF Maximum Elevation at Top of Active Storage – 985 feet msl Minimum Operating Elevation – 570 feet msl Surface Area at Top of Active Storage – 5,700 acres
Temperance Flat Dam	Location – San Joaquin River Mile 274 Straight Roller-Compacted Concrete Gravity Dam Maximum Height – 665 feet Crest Length – 2,560 feet Volume – 5.1 Million Cubic Yards
Spillway	Location – Center Section of Temperance Flat Dam Type – Uncontrolled Ogee Width – 665 feet Capacity – 129,182 cfs
Selective Level Intake Structure	Location – Left Bank, 7,200 feet Upstream From Dam Dimensions – Inclined 800 foot long reinforced concrete structure Normal Operating Range - up to 10,000 cfs Maximum Intake Capacity - 20,000 cfs Number of Ports – 4
Outlet Works	Feature Items and Location – Diversion Tunnel Converted to Outlet Tunnel; Valvehouse Located at Downstream End of Tunnel Downstream from Temperance Flat Reservoir along Millerton Lake Tunnel Dimensions – 3,050 feet in length; 30 feet in diameter Maximum Outlet Capacity – 20,000 cfs (4 valves)
Hydroelectric and Related Facilities	Feature Items and Location – Kerckhoff No. 2 Tunnel Extension; Powerhouse Located at Downstream End of Tunnel Downstream from Temperance Flat Reservoir along Millerton Lake Generating Capacity - 160 MW Kerckhoff No. 2 Tunnel Extension Length – 37,720 feet
Utility Relocations	Facility Decommissioning – Kerckhoff Hydropower Project Powerhouses and Kerckhoff Tunnel/Intake Relocations – Two High Voltage Power Lines, Minor Low Voltage Power Lines
Recreation Facilities	Additional Recreation Facilities – Could be Developed as Feasible Facility Relocations – San Joaquin River Trail, Several Campgrounds, and Bureau of Land Management Facilities
Roads	Additional Roads – 5 Miles of Permanent Access Roads; 10 Miles of Temporary Access Roads Road Re-alignments – None Required

Cfs	=	cubic feet per second	msl	=	mean sea level
MW	=	megawatt	TAF	=	thousand acre feet

Operations assumptions for the example Temperance Flat RM 274 Reservoir project formulation presented in this report include:

- **Full integration with operations of the SWP and CVP** – Operations integration with the SWP and CVP would include coordinated management of water supplies in Millerton Lake and Temperance Flat RM 274 Reservoir with operations of SWP and other CVP facilities (See Figure 4-4). This would involve delivery of water supplies to the Friant Division in combination with water exchanges between the Friant Division and SWP and other CVP service areas. Some SWP or CVP water supplies from the Delta that are diverted to San Luis Reservoir would instead be delivered to water users in the Friant Division of the CVP, while San Joaquin River water would be stored in the new reservoir. This would provide additional available storage space in San Luis Reservoir during wet periods, which could allow capture of additional supplies from the Delta. Accumulated San Joaquin River water supplies would be provided through exchange to SWP and CVP SOD water users when Delta supplies are less than demand. Thus, Temperance Flat RM 274 Reservoir would not only be operated as an enlargement of Millerton Lake for managing flood or high flows on the San Joaquin River (functioning as a reservoir upstream of the Delta), but would also be operated as an expansion of SOD offstream storage like a San Luis Reservoir on the east side of the San Joaquin Valley to capture additional Delta supplies through exchange (functioning as a reservoir downstream of the Delta).

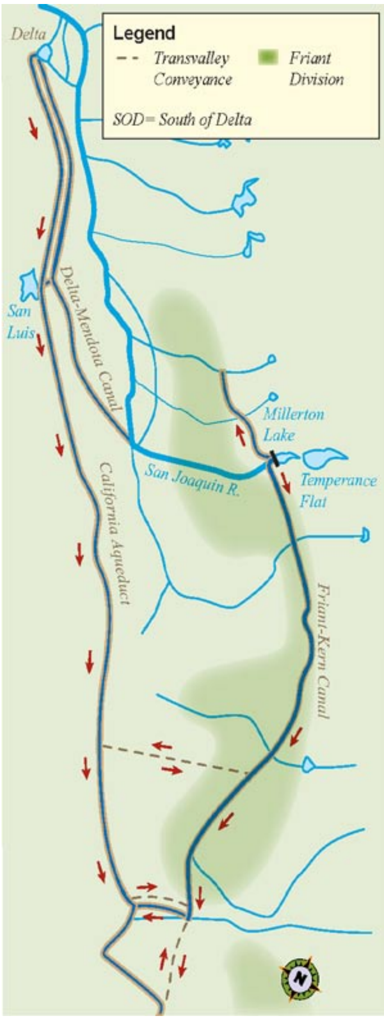

Figure 4-4. Integrated Operations of South-of-Delta Facilities

- **Transvalley conveyance via Shafter-Wasco Pipeline, Cross Valley Canal, and Arvin-Edison Canal** – To facilitate operations integration of Millerton Lake and Temperance Flat RM 274 Reservoir with the SWP and CVP systems, transvalley water exchanges (east to west or west to east) would be accomplished using assumed available capacity in the Shafter-Wasco Pipeline, Cross Valley Canal, and Arvin-Edison Canal. The Friant-Kern Canal and California Aqueduct would also be necessary conveyance components for water exchanges. Water stored in Temperance Flat RM 274 Reservoir could also be released from Friant Dam to Mendota Pool and then delivered to CVP or SWP users through exchanges.

- **Reservoir balancing** –When both reservoirs are not full, the storage levels in Temperance Flat Reservoir and Millerton Lake would be operated in a coordinated manner to balance effects on recreation, hydropower, and temperature. The amount of total storage available would dictate the water supply that could be developed for multiple purposes.

For the purposes of this report, water operations modeling was performed to determine potential changes in water supply deliveries to agricultural and M&I water contractors and Level 4 water supplies for California's wildlife refuges, water quality improvements, and ecosystem restoration. The modeling summarized in this report was performed using a combination of CALSIM for the operations of San Joaquin River supplies and the Friant Division of the CVP and a spreadsheet-based model for integrating the operations of Temperance Flat RM 274 Reservoir with the broader CVP and SWP systems through exchange. The spreadsheet model is a conservative, simplified approach that typically underestimates the magnitude of potential benefits of operations integration with the CVP and SWP.

Example Temperance Flat RM 274 Reservoir Project Formulation Benefits

This section describes the results of modeling conducted for the example formulation of Temperance Flat RM 274 Reservoir that includes new operating criteria recommended by the 2008/2009 BOs for delta smelt and salmon and summarizes potential project benefits. This section describes how the example formulation of a Temperance Flat RM 274 Reservoir project would meet primary objectives and achieve project benefits, including public benefits. This presentation distinguishes between public and non-public benefits based on guidance from the 2009 Comprehensive Water Package. According to the 2009 Comprehensive Water Package, public benefits may include ecosystem improvements, water quality improvements, flood control benefits, emergency response, and recreation. Water supply reliability and water quality benefits for M&I and agricultural users and hydropower generation are assumed to be non-public benefits and would need to be paid for by the beneficiaries.

The information presented in this section is for informational purposes only. The example project components and operations were formulated to fulfill a wide variety of project benefits and may not represent the most technically and/or economically feasible alternative considered in past and/or future feasibility study reports and environmental impact documents, and should not be considered as a preferred alternative.

With Temperance Flat RM 274 Reservoir in place and a representation of operational conditions described in the PFR (i.e., 2004/2005 Operations Criteria and Plan), a long-term annual average water supply of approximately 180 TAF would be developed, with 70 TAF attributed to operations integration. For the purposes of this report, a representation of operational conditions described in the 2008/2009 BOs results in a long-term annual average water supply (for period October 1922 to September 2003) of approximately 140 TAF, which could be developed for multiple purposes. The dry year average (combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992) would be about 86 TAF. The need for the available storage space in Temperance Flat RM 274 Reservoir to be used for exchanges is closely tied to the frequency of filling San Luis Reservoir. About 30 TAF of the approximately 140 TAF long-term average water supply developed would be attributed to operations integration. Water supplies developed with an example formulation of Temperance Flat RM 274 Reservoir could be used for a variety of purposes to provide a wide range of public benefits and other benefits, as described below. The water stored in Temperance Flat RM 274 Reservoir (San Joaquin River supplies and CVP/SWP exchange supplies) and the proportion of water supply that could be dedicated for each purpose has not yet been determined. These benefits and their distribution will be further evaluated in the Draft Feasibility Report. For modeling convenience in quantifying the amount of water that could be developed with an example formulation of Temperance Flat RM 274 Reservoir in this report, the operation of the reservoir was analyzed with a water supply focus.

Potential benefits are illustrated on Figure 4-5.

Note: Map not to scale

Figure 4-5. Summary of Potential Benefits of the Example Temperance Flat RM 274 Project

Public Benefits

The example formulation of Temperance Flat RM 274 Reservoir could provide public benefits, including ecosystem improvements, water quality improvements, flood control benefits, emergency response benefits, and recreational benefits, as described in the following sections.

Ecosystem Improvements

A Temperance Flat RM 274 Reservoir has potential to improve habitat conditions in the San Joaquin River by managing temperature of flow releases and by facilitating release of additional flows to the San Joaquin River in critically dry years. Temperance Flat RM 274 Reservoir would also provide cold water management flexibility through increased volumes of cold water that would be available for management and release to the San Joaquin River. The average end of September storage in Millerton Lake and Temperance Flat RM 274 Reservoir for this future condition is about 720 TAF compared to 220 TAF in Millerton Lake in the without project condition. The increase in early fall cold water volume would enhance conditions for anadromous fish downstream from Friant Dam (assuming implementation of the San Joaquin River Restoration Program [SJRRP]) during the spawning and incubation period occurring in the fall.

Ecosystem improvements could also be provided through operational integration of Millerton Lake and Temperance Flat RM 274 Reservoir with the SWP and CVP systems, which would improve management of Delta exports and allow for shifting of SWP and CVP pumping operations to times less damaging to sensitive Delta fish species. The ability to store additional San Joaquin River water in Temperance Flat RM 274 Reservoir could also result in additional Class 2 deliveries in the Friant Division which are used for conjunctive management and would reduce reliance on groundwater pumping in the overdrafted San Joaquin Valley aquifers. Water released from Friant Dam for exchange at Mendota Pool through operations integration actions could also enhance water temperature and flow conditions to improve aquatic habitat in the San Joaquin River. Water from Temperance Flat RM 274 Reservoir could also be dedicated to the San Joaquin River and Delta for ecosystem purposes, or to preserve and enhance other river system public trust resources.

Water Quality Improvements

No new modeling on San Joaquin River water quality opportunities was conducted for this report. For a potential Temperance Flat RM 274 Reservoir, this opportunity would be considered to the extent it can be implemented in conjunction with actions to achieve the primary objectives. Water quality conditions in the San Joaquin River would likely improve through implementation of the San Luis Drainage Feature Reevaluation selected alternative, SJRRP actions, and various water quality improvement programs and activities. Water quality in the San Joaquin River could also be improved if water is released from Friant Dam for exchanges at Mendota Pool through operations integration actions. These exchanges could improve the water quality of agricultural return flows to the San Joaquin River downstream from Mendota Pool. The extent of water quality improvements is difficult to anticipate until water quality monitoring and analyses are completed for these actions.

Flood Control Benefits/Flood Protection

No new modeling on flood risk management opportunities was conducted for this report, though previous study results show that Temperance Flat RM 274 Reservoir would provide significant incidental flood control space that would improve the management of flood flows at Friant Dam. A series of evaluations in previous stages of the feasibility study estimated potential flood protection benefits that would result from dedicating a range of additional floods storage space at or upstream from Millerton Lake. These evaluations found that potential flood protection benefits resulting from incidental availability of flood storage space would be similar to those that would result from the dedication of additional flood storage space. For a potential Temperance Flat RM 274 Reservoir, this opportunity would be considered to the extent it can be implemented in conjunction with actions to achieve the primary objectives.

Emergency Response/Storage

Temperance Flat RM 274 Reservoir's strategic location south of the Delta and its large storage capacity would provide both long-term and emergency water supply benefits for much of the state. A Temperance Flat RM 274 Reservoir could provide a source of short-term emergency water supplies to SOD water users in the event of a disruption in Delta water supplies caused by levee failure during a seismic event. Such an event in the Delta would disrupt the ability to pump water from the Delta and deliver to SOD SWP and CVP water users. In addition to natural events, future environmental constraints may periodically limit the amount of water that can be delivered through Delta SWP and CVP pumping facilities. Water from Temperance Flat RM 274 Reservoir could be immediately available to SOD water users (either directly or through exchange), since the water would already be stored south-of-the-Delta.

Recreational Purposes

No new modeling or analysis on recreation opportunities was conducted for this report. Opportunities for recreation development vary depending on operations integration and Millerton Lake reservoir balancing options. In the PFR, simulation results indicate improved recreation opportunities in the primary study area when Temperance Flat RM 274 Reservoir is balanced to maintain Millerton Lake water levels at baseline average monthly storage levels or higher. Higher pool elevations would provide a minor potential benefit to boaters, while maintaining good shoreline use conditions. Boating and waterskiing activities provided by the new reservoir would provide the greatest recreational value.

Water Supply Reliability Benefits

A Temperance Flat RM 274 Reservoir would capture flows from the upper San Joaquin River basin that could be delivered to water users. The additional storage space in the new reservoir would provide opportunities for water exchanges with other SOD water users by integrating storage operations with SWP and other CVP facilities. Municipal, industrial, and agricultural water users would benefit from additional surface water deliveries, which could increase SOD agricultural and M&I water supply reliability, reduce reliance on groundwater supplies, and reduce aquifer drawdown.

Water stored in Temperance Flat RM 274 Reservoir could also be delivered as Level 4 refuge supplies to Tulare Basin and San Joaquin Valley wildlife refuges. Level 4 refuge water supply reliability improvements could be considered a public benefit.

M&I Water Quality Benefits

Through development and management of San Joaquin River supplies, there may be opportunities to improve the quality of water supplies delivered to urban areas over the range of hydrologic conditions. Integrating operations of Friant Dam and Temperance Flat RM 274 Reservoir with operations of the SWP and CVP systems would allow for increased Delta exports during wet conditions, and the potential to reduce exports during dry periods, through exchange of water supplies. Water exported during wet periods would be of higher quality. Operations integration of Friant Dam and Temperance Flat RM 274 Reservoir with the SWP and CVP would also facilitate water quality exchanges to make high quality upper San Joaquin River water available to urban interests receiving water from the Delta. Improvements in raw water quality can benefit urban water users through a reduction in treatment costs required to attain a given level of finished water quality.

Hydropower/Flexible Generation

No new modeling or analysis on hydropower generation opportunities was conducted for this report. Previous PFR studies show most hydropower for a potential Temperance Flat RM 274 Reservoir would be generated by diverting flow into an extended Kerckhoff No. 2 Powerhouse tunnel at Kerckhoff Lake and discharging flow through a new powerhouse located just downstream from Temperance Flat RM 274 Dam into Millerton Lake (See Figure 4-3). This would take advantage of the relatively constant water level in Kerckhoff Lake. Releases from Temperance Flat RM 274 Reservoir would also be used for power generation. Per analysis done for the PFR, power generation for this hydropower configuration would generate enough energy to replace more than 95 percent of the energy lost through inundation of the Kerckhoff Project powerhouses, on an average annual basis. Other hydropower configurations that vary reservoir water level balancing and the percent of flow routed through Temperance Flat RM 274 Reservoir would generate between 65 and 95 percent of the energy lost. Future gains in hydropower benefits may be realized by utilizing the additional storage of Temperance Flat RM 274 Reservoir to carry over water supplies later in the year for power generation, whereas the existing Kerckhoff project has very limited storage. Additional opportunities may also be realized by adding a pumped storage component to a hydropower configuration, which would take advantage of California's rising renewable energy market and its dependence on hydropower and other flexible generation/storage resources for power regulation (i.e., shaping wind/solar generation on a second-by-second basis to meet electrical demand and allow for reliable operation of the electric grid).

Example Temperance Flat RM 274 Reservoir Project Formulation Benefits Under an Uncertain Future

As stated previously in this report, future conditions are uncertain at this time and considered projects must be able to fulfill project objectives and provide benefits under variable future conditions. This section describes modeling conducted for an example formulation of Temperance Flat RM 274 Reservoir coordinated with potential new Delta conveyance and presents qualitative analysis on the potential for climate change to impact the ability of a Temperance Flat RM 274 Reservoir to achieve intended benefits. The information presented in this section is for informational purposes only.

Potential Effect of New Delta Conveyance on Project Benefits

This section presents how an example formulation of Temperance Flat RM 274 Reservoir could accomplish project objectives and provide benefits under future operation scenarios that include potential new Delta conveyance, as being studied by the Bay-Delta Conservation Plan and Delta Habitat Conservation and Conveyance Program. This section focuses on quantitative and qualitative analyses conducted for public benefits, including ecosystem improvements, water quality improvement, emergency response and recreational purposes; and water supply reliability, M&I water quality, and hydropower generation. Other benefit categories discussed in previous sections, such as flood protection, are not expected to change significantly with new Delta conveyance; however, further analysis will be conducted as the feasibility study progresses. The same modeling tools (CALSIM and simplified spreadsheet model, as discussed above) were used; therefore, the results are impacted by the same limitations. These limitations are only exacerbated by the uncertainty associated with potential new Delta conveyance.

With Temperance Flat RM 274 Reservoir in place and a representation of operations including new Delta conveyance and the BOs, a long-term annual average of approximately 230 TAF of water could be developed for multiple purposes. The dry year average would be about 149 TAF. The frequency of filling San Luis Reservoir is much greater under future operation scenarios that include potential new Delta conveyance than those without new Delta conveyance. New Delta conveyance increases the utilization of the available storage space in Temperance Flat for exchanges and the corresponding water supply that could be developed for multiple purposes. About half of the approximately 230 TAF long-term average water developed would be attributed to operations integration.

As with the future scenario without new Delta conveyance, the operations of the reservoir was analyzed with a water supply focus for modeling convenience in quantifying the amount of water that could be developed, but the water stored in Temperance Flat RM 274 Reservoir (San Joaquin River supplies and CVP/SWP exchange supplies) could be dedicated to provide a wide range of public benefits and other benefits, as described below.

Ecosystem Improvements

New Delta conveyance would increase the volume of water supply stored in Temperance Flat RM 274 Reservoir through exchange and would increase the cold water pool. The average end of September storage in Millerton Lake and Temperance Flat RM 274 Reservoir for a future condition with new Delta conveyance is about 850 TAF, compared to 720 TAF in the future condition without new Delta conveyance (an increase of 130 TAF). The increase in early fall cold water volume would further enhance conditions for anadromous fish downstream from Friant Dam (assuming implementation of the SJRRP) during the spawning and incubation period occurring in the fall.

With new Delta conveyance, storage in Temperance Flat RM 274 Reservoir and Millerton Lake could be better balanced and coordinated with reservoirs throughout the CVP and SWP system, such as San Luis Reservoir, Folsom Lake, Lake Oroville, Shasta Lake, and New Melones Reservoir. This coordination of reservoirs could be used to enhance Delta and river ecosystems under a variety of ecological and regulatory needs and constraints. For example, through timing of operations integration flow, Temperance Flat RM 274 could have storage available in drier conditions. This water could be released during these conditions to satisfy Delta flow needs, reducing the need for releases from Sacramento River Basin reservoirs. This could improve cold water pool conditions in Sacramento River Basin reservoirs, for later anadromous fish releases, without sacrificing ecosystem conditions in the Delta. Water could then be replenished in Temperance Flat RM 274 Reservoir during wetter conditions or when Sacramento River Basin reservoirs release additional stored water as environmental conditions allow. This example of ecosystem improvement would be made possible and would use less water than alternative scenarios without new Delta conveyance or a Temperance Flat RM 274 Reservoir.

Water Quality Improvements

As mentioned, no new modeling on San Joaquin River water quality opportunities was conducted for this report, though benefit opportunities in water quality will be explored in future feasibility study efforts. An example formulation of Temperance Flat RM 274 Reservoir coordinated with potential new Delta conveyance could benefit river water quality in a similar manner to the Sacramento River Basin reservoirs integration and timing of flows discussed in the “Ecosystem Improvements” section. Water stored in Temperance Flat RM 274 Reservoir through operations integration could be released to improve San Joaquin River water quality. This water could then be exported from the southern Delta and returned to the water users, resulting in minimal water cost. During the time water is being released down the San Joaquin River, a reduction in Sacramento River inflows may be possible, as well as, decreases in releases from San Joaquin River tributaries. Water quality improvements in the San Joaquin River could also be achieved if water is released from Friant Dam for exchanges at Mendota Pool through operations integration actions resulting in improved water quality of agricultural return flows to the San Joaquin River downstream from Mendota Pool.

Emergency Response/Storage

Temperance Flat RM 274 Reservoir storage would likely be significantly higher in a future condition with new Delta conveyance than in a future condition without improved Delta conveyance. This increased storage would result in an increase in time a high quality emergency water supply would be available. Although the probability of a Delta outage is less under a future condition with new Delta conveyance, this supply is located south of the Delta and could be available if the California Aqueduct is damaged.

Recreational Purposes

There is a potential that as additional water is stored in Temperance Flat RM 274 Reservoir through exchanges enhanced by new Delta conveyance, conditions for recreation would be improved. This improvement could occur via more flexibility in balancing the water levels in the two reservoirs that would benefit recreational purposes.

Water Supply Reliability Benefits

New Delta conveyance could significantly enhance the magnitude of M&I, agricultural, and Level 4 Refuge (public benefit) water supply accomplishments of Temperance Flat RM 274 Reservoir, as discussed in the previous water supply reliability section without new Delta conveyance. New Delta conveyance could increase the ability to move water supply south of the Delta in wet years, resulting in improved flexibility for exchange operations integrating Temperance Flat RM 274 Reservoir with the CVP and SWP systems. With new Delta conveyance, there could also be opportunities for direct delivery of Delta water supplies to the Friant Division (bypassing storage in San Luis Reservoir).

M&I Water Quality Benefits

Operations integration of Friant Dam and Temperance Flat RM 274 Reservoir with the SWP and CVP, under new Delta conveyance conditions, could facilitate water quality exchanges to make high quality upper San Joaquin River water available to urban interests. North-of-Delta water quality delivered to SOD M&I water users, however, would be improved with new Delta conveyance, and the incremental water quality improvement with Temperance Flat RM 274 Reservoir would be small. Improvements in raw water quality can benefit urban water users through a reduction in treatment costs required to attain a given level of finished water quality.

Hydropower/Flexible Generation

Operations integration has typically resulted in minor changes in hydropower benefits. There is a potential that as additional water is stored in Temperance Flat RM 274 Reservoir through exchanges enhanced by new Delta conveyance, conditions for hydropower would be improved with higher water levels. The increase in benefits would be dependent on the coordination of Temperance Flat RM 274 Reservoir and Millerton Lake water levels, and releases for the multiple purposes of water supply, release temperatures, and reservoir recreation.

Potential Effect of Climate Change on Project Benefits

Potential effects from climate change underscore the need for additional storage. For the San Joaquin River basin, climate change could affect surface water supplies provided from snowpack in the high mountain headwaters. Climate change resulting in future warming could lead to more rain and less snow, more rainfall-runoff during winter and early spring and less snowmelt volume during late spring and summer, and increased crop water needs.

Future warming could cause a greater fraction of annual runoff to occur during winter and early spring and the fraction of annual runoff during late spring and summer could decrease. This could result in impacts to existing water supplies as additional flood control releases would need to be made and less water would be stored later in the season and flood control rules are relaxed. To the extent that climate change would cause a greater fraction of annual runoff in the upper San Joaquin River basin to occur during winter and early spring, the need for additional storage would be further underscored. Temperance Flat RM 274 Reservoir would provide additional incidental flood control space.

Further, sea level rise from global climate change could affect Delta conditions that constrain SWP and CVP operations in the Delta, and also lead to changes in upstream operations in the San Joaquin River basin.

Temperance Flat RM 274 Reservoir Potential Environmental Effects

Primary potential effects for aquatic biological resources, terrestrial biological resources, recreation resources, and cultural resources affected by the Temperance Flat RM 274 Reservoir alternative plans are described in the PFR. Examples of potential adverse effects described in the PFR include inundation of terrestrial habitats and associated species, including special status species, affected usable habitat for riverine fish species, inundation of historic or prehistoric cultural resources sites of concern, and affected recreation resources. Potential beneficial effects, such as improved water temperature conditions in the San Joaquin River below Friant Dam, increases in shallow-water habitat for lake species, and improved recreation opportunities, are also described in the PFR.

Additional environmental analyses will be completed during the feasibility study that will inform the nature of potential mitigation and/or enhancement measures included in the Temperance Flat RM 274 Reservoir alternative plans, and included in the Draft and Final Feasibility Report and accompanying EIS/EIR. Construction of a new reservoir in the upper San Joaquin River basin would be subject to the requirements of numerous federal, state, and local laws, policies, and regulations. The Bureau of Reclamation (Reclamation) is the lead agency for National Environmental Policy Act (NEPA) compliance, and the Department of Water Resources (DWR) is the lead agency for California Environmental Quality Act (CEQA) compliance. Moreover, Reclamation would need to obtain various permits and meet regulatory requirements before beginning any project construction, and comply with a number of environmental regulatory requirements as part of the NEPA and CEQA compliance process.

A draft EIS/EIR disclosing environmental impacts resulting from the USJRBSI is scheduled for release in 2011. Environmental studies and evaluations are currently being conducted to determine the type and extent of potential environmental impacts. It is anticipated that some of the adverse effects would be temporary, construction related effects and other adverse effects would be permanent, such as effects on botanical and wildlife resources within the newly inundated areas. As part of the project planning and environmental assessment process, DWR and Reclamation will incorporate environmental commitments and best management practices to avoid or minimize potential effects. DWR and Reclamation have also committed to coordinate with applicable resource agencies and tribal groups during planning, engineering, design, construction, operation, and maintenance phases of the project.

Chapter 5 Los Vaqueros Expansion Investigation

This project would expand Los Vaqueros Reservoir in Contra Costa County, California (See Box 5-1). The project would enhance the Sacramento-San Joaquin Delta (Delta) (See Box 5-2 for a list of acronyms and abbreviations used in this section) environment, and would also improve water supply reliability and water quality for Delta water users in the San Francisco Bay Area.

Box 5-1. Why Los Vaqueros Reservoir is an Ideal Site for Expanded Storage:

- Adjacent to Delta
- Close to existing state and federal water conveyance systems
- Delta intake locations that minimize fish loss
- Surrounded by protected open space & watershed lands
- Proven ability to achieve multiple benefits with the existing Los Vaqueros Reservoir

Box 5-2. Chapter 5 Acronym and Abbreviation List

Bay Area	San Francisco Bay Area
BDCP	Bay-Delta Conservation Plan
CCWD	Contra Costa Water District
cfs	cubic foot per second
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
DWR	Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
IAIR	Initial Alternatives Information Report
IEEPF	Initial Economics Evaluation Report for Plan Formulation
NA	not applicable
NOI	Notice of Intent
NOP	Notice of Preparation
Reclamation	United States Bureau of Reclamation
SBA	South Bay Aqueduct
SCVWD	Santa Clara Valley Water District
SF	San Francisco
SWP	State Water Project
TAF	thousand acre-feet

Project Location

Los Vaqueros Reservoir, owned and operated by the Contra Costa Water District (CCWD), lies in the foothills west of the Delta and east of the San Francisco Bay Area (Bay Area), in Contra Costa County (Figure 5-1). It is an off-stream reservoir, meaning that it relies on water being pumped into it from another location (in this case, the Delta), rather than the reservoir being located on a river or stream and intercepting natural flows. Off-stream reservoirs have advantages in terms of maintaining fisheries and aquatic ecosystems because they do not interrupt the natural course of rivers or streams, and thus do not block fish passage. They can also have operational advantages because they are subject to fewer restrictions on storage during winter months to maintain room for flood protection. However, they generally require power inputs to pump water into off-stream reservoirs, and their ability to capture water during high flows is limited by the capacity of the pumping stations and pipelines feeding the reservoir.

Los Vaqueros Reservoir is strategically located adjacent to the Delta and in close proximity to the major state and federal water facilities exporting water from the Delta (Figure 5-2). The location of Los Vaqueros Reservoir offers significant advantages for providing regional and statewide benefits. The reservoir is centrally located near several other important water supply facilities, including the South Bay Aqueduct (SBA) and the canals that serve the San Felipe Unit of the Central Valley Project (CVP). The Los Vaqueros Reservoir Expansion Project has been designed to convey Delta water to Bay Area water agencies that receive their current supplies of Delta water through the existing facilities in the south Delta.

The expanded reservoir would also be constructed with state-of-the-art positive barrier fish screens, which create ecosystem benefits and improve water supply reliability by avoiding impacts to fish in the Delta. The existing Los Vaqueros Reservoir employs this technology very successfully in the south Delta. The expanded Los Vaqueros Reservoir could enhance water supply reliability for Bay Area water agencies that currently rely on the SBA and the San Felipe Unit, through providing increased storage, and could simultaneously create benefits for the Delta ecosystem by improving fish screen capacity for these diversions.

The reservoir is located in a largely undeveloped part of Contra Costa County and preserves open space in the greater watershed. This reservoir protects water quality and provides habitat and recreational opportunities.

Project Objectives

Existing Reservoir

CCWD constructed, owns, and operates the existing Los Vaqueros Reservoir primarily to improve water quality for CCWD customers, and to provide stored water for emergencies. The reservoir is also operated to protect fish in the Delta. The existing reservoir facilities include a 100 thousand acre-foot (TAF) reservoir, a 20,000 acre protected watershed, Delta intakes on Old River and Victoria Canal (CCWD's Alternative Intake Project, which as of June 2010 is in start-up testing), pipelines, and related facilities. A preliminary phase of the expansion project is being conducted by CCWD. The existing reservoir is going to be expanded to a total capacity of 160 TAF. This expansion does not preclude further expansion of the Los Vaqueros Reservoir, but will provide immediate increased benefits to CCWD.

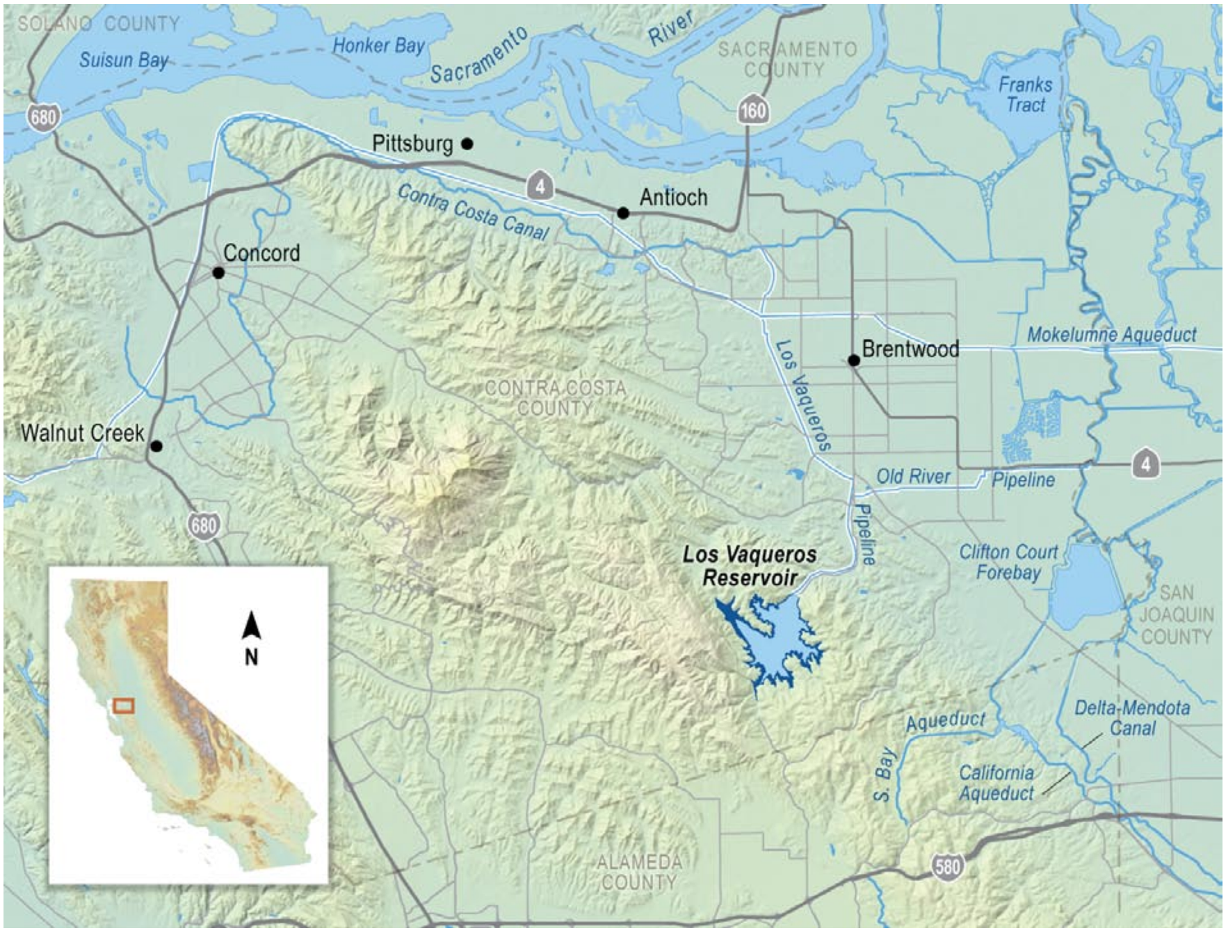

Figure 5-1. Los Vaqueros Reservoir Project Location

The water storage capacity of the existing Los Vaqueros Reservoir allows CCWD to improve the water quality delivered to its customers by adjusting the timing of its Delta water diversions throughout the year to store water when the Delta is freshest, and then release that stored water later in the year to blend with higher salinity Delta water. This operation inherently shifts CCWD pumping from dry years to wetter years, and provides dry year water supply reliability for CCWD. The existing reservoir also allows CCWD's operations to accommodate the life cycles of Delta aquatic species, by limiting diversions at critical times, thus reducing species impact and providing a net benefit to the Delta environment. These are the benefits that will be extended for CCWD by expanding the reservoir capacity to 160 TAF.

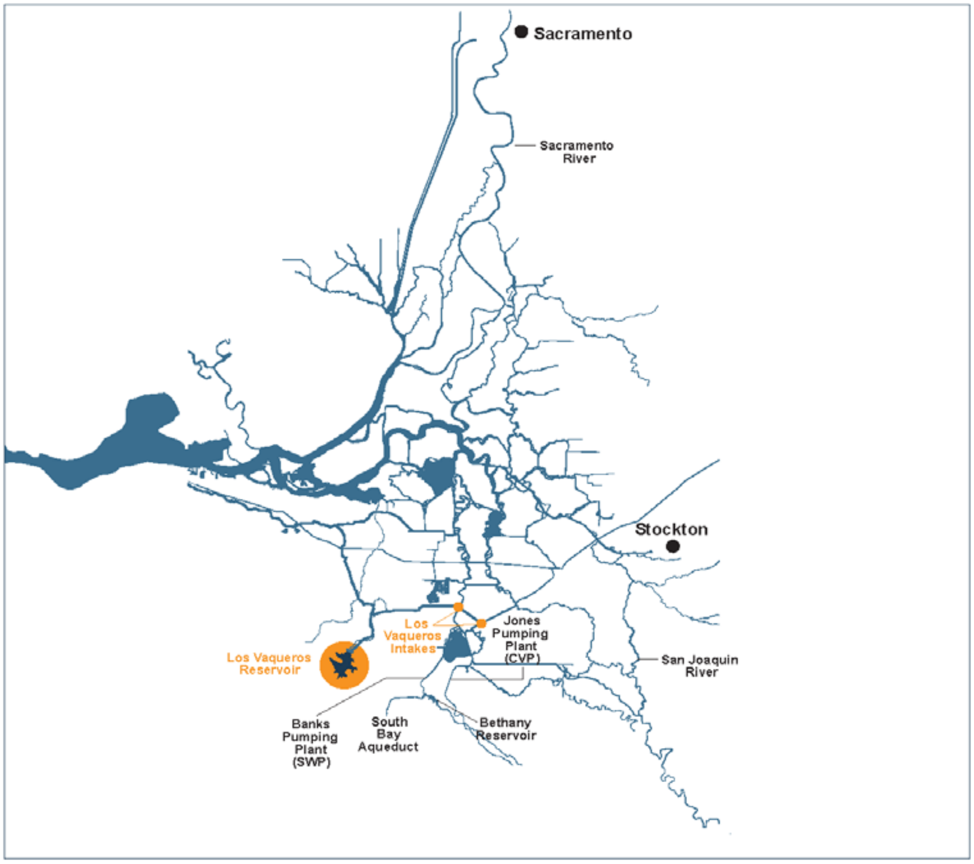

Figure 5-2. Location of Los Vaqueros Reservoir Relative to the Delta

Expanded Reservoir

Further expansion of the reservoir and related facilities would provide an opportunity to expand these benefits, and improve related system reliability and flexibility, through a cooperative effort among CCWD and other project participants. The project would include expanding the reservoir to a capacity of 275 TAF and constructing additional intake and conveyance facilities. Through the use of the expanded reservoir and related facilities, along with existing CCWD facilities and assets, and through coordinated operations with the State Water Project (SWP) and CVP, fishery protection and Bay Area water supply reliability can be substantially improved.

The Los Vaqueros Expansion Investigation objectives are to use an expanded Los Vaqueros Reservoir system to achieve the following objectives:

Primary Objectives

- Develop water supplies for environmental water management that supports fish protection, habitat management, and other environmental water needs
- Increase water supply reliability for water providers within the San Francisco Bay Area, to help meet municipal and industrial water demands during drought periods and emergencies or to address shortages due to regulatory and environmental restrictions

Secondary Objective

- Improve the quality of water deliveries to municipal and industrial customers in the San Francisco Bay Area, without impairing the project's ability to meet the environmental and water supply reliability objectives stated above

In addition to these objectives, CCWD Board of Directors' Resolution No. 03-24 (See Box 5-3) provides important guidance for identifying and evaluating plans involving the expansion of the reservoir.

Box 5-3. CCWD Board of Director's Resolution No. 03-24

In Resolution No. 03-24 the Contra Costa Water District (CCWD) Board determined "that the District will not participate in or support the CALFED Bay-Delta Program proposal for expansion of Los Vaqueros Reservoir unless the Board determines that the CALFED Bay-Delta Program proposal meets the following conditions:

1. Improves drinking water quality for CCWD customers beyond that available from the existing Los Vaqueros Project;
2. Improves the reliability of water supplies for CCWD customers during droughts;
3. Enhances Delta habitat and protects endangered Delta fisheries and aquatic resources by installing state-of-the-art fish screens on all new intakes and creating an environmental asset through improved location and timing of Delta diversions and storage of water for environmental purposes;
4. Increases the protected land and managed habitat for terrestrial species in the Los Vaqueros Watershed and the surrounding region;
5. Improves and increases fishing, boating, hiking, and educational opportunities in the Los Vaqueros Watershed, consistent with the protection of water quality and the preservation of the watershed and the watershed's unique features;
6. CCWD continues as owner and manager of the Los Vaqueros Watershed;
7. CCWD maintains control over recreation in the Los Vaqueros Watershed;
8. CCWD continues as operator of the Los Vaqueros Reservoir system;
9. CCWD will be reimbursed for the value of the existing Los Vaqueros Project assets shared, replaced, rendered unusable or lost with the expansion project and said reimbursement will be used to purchase additional drought supply and water quality benefits or reduce debt on the existing Los Vaqueros Project;
10. Water rates for CCWD customers will not increase as a result of the expansion project."

Project Formulation and Alternatives

CCWD and the Department of Water Resources (DWR) first began studying a possible expansion project in January 2001. The proposed project was developed and refined through the course of detailed studies with CCWD, DWR, and the Bureau of Reclamation (Reclamation) and extensive public outreach. Public outreach on Los Vaqueros Expansion Investigation has included 30 public meetings, 35 CCWD Board meetings open to the public, formation of a Customer/Stakeholder Feedback Group and Agency Coordination Work Group, distribution of fact sheets, press releases, postcards, and newsletters, and the maintenance of a project website (www.lvstudies.com) with documents and other related material posted for public review (See Box 5-4).

Box 5-4. Reports Related to the Los Vaqueros Expansion Investigation

Environmental Impact Statement (EIS)/Environmental Impact Report (EIR)

In February 2009, the Bureau of Reclamation (Reclamation) and Contra Costa Water District (CCWD) published a joint Draft EIS/EIR that evaluated the environmental effects of expanding LosVaqueros Reservoir. Following a series of public hearings and extended comment period, the project team prepared a Final EIS/EIR that was released in March 2010. The final document includes responses to all comments received on the Draft EIS/EIR.

Initial Economics Evaluation Report for Plan Formulation (IEEPF)

The IEEPF (Reclamation, 2006) provides an economic and plan formulation update to decision-makers at Reclamation and the Office of Management and Budget. The IEEPF determined that expansion of Los Vaqueros is cost effective and can be implemented while meeting the CCWD Board Principles.

December 2005 Notice of Intent (NOI) and January 2006 Notice of Preparation (NOP)

The NOI published by Reclamation in the Federal Register notifies agencies of the preparation of the EIS/EIR for the project. The NOP published by CCWD describes the proposed project alternatives reviewed in the EIS/EIR and identifies the main environmental issues to be addressed during the environmental review.

November 2005 Initial Alternatives Information Report (IAIR)

The IAIR (Reclamation, 2005b) describes formulation of initial alternative plans to address the problems, opportunities, and planning objectives identified that primarily involve enlarging the Los Vaqueros Reservoir.

April 2004 Final Draft Planning Report

The Final Draft Planning Report (CCWD, 2004) presents the information developed during the planning phase of the Los Vaqueros Reservoir Expansion Studies and incorporates comments received to date.

Following preliminary planning studies that demonstrated the expansion project could result in environmental, water supply reliability, and water quality benefits, voters in CCWD's service area were asked to vote on whether CCWD should continue to study expansion of its reservoir. The 2004 advisory ballot measure won approval of 62 percent of voters.

Through the course of studying and refining the project, various alternatives were considered, including different levels of reservoir expansion (up to 500 TAF), and various pumping and conveyance configurations. A project including a 275 TAF reservoir and increased diversion and conveyance facilities was selected for evaluation in the Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the project, because this combination of facilities maximized public and regional benefits while minimizing capital costs and adverse impacts to the environment. A smaller alternative, including a 160 TAF reservoir, was also evaluated. These analyses are described in detail in the Initial Alternatives Information Report (Reclamation, 2005b) and the Final EIS/EIR (Reclamation and CCWD, 2010).

The CCWD Board of Directors certified the Final EIS/EIR and approved the expansion to 160 TAF (Alternative 4 in the EIS/EIR) on March 31, 2010. CCWD is moving forward with design and construction of the 160 TAF expansion in the near term to provide immediate local benefits that include providing drought reliability, improving water quality, helping the environment, and creating jobs. Construction of the 160 TAF expansion is scheduled to begin in 2011.

Expansion of Los Vaqueros to 160 TAF in the near term would not preclude future expansion with commitments from local, state, and/or federal partners. DWR, Reclamation and other potential local partners may choose to continue to study the feasibility of a 275 TAF expansion alternative in the context of other Delta initiatives to improve Delta conveyance and better protect Delta fisheries, including long-term programs being explored in the Bay-Delta Conservation Plan (BDCP).

The example project as evaluated in this Progress Report would expand Los Vaqueros Reservoir from the planned storage capacity of 160 TAF to 275 TAF. Diversion capacity from the Delta would be increased, as would capacity of the existing conveyance facilities that move water from the Delta to the Los Vaqueros Reservoir. Figure 5-3 shows the major components of the example project.

A South Bay connection, including a new pipeline would be constructed, linking the Los Vaqueros Reservoir system to Bethany Reservoir, which serves as a forebay for the SBA, and is also connected by the California Aqueduct to the San Felipe Unit facilities in San Luis Reservoir. Three Bay Area water agencies are served by the SBA: Alameda County Flood Control and Water Conservation District, Zone 7; Alameda County Water District; and Santa Clara Valley Water District (SCVWD). SCVWD also receives deliveries of Delta water through the San Felipe Unit. The expanded Los Vaqueros Reservoir could serve these South Bay water agencies that currently receive Delta water supplies through the CVP and SWP export facilities in the south Delta, while improving system flexibility, water supply reliability, and environmental protection.

Example 275 TAF Los Vaqueros Reservoir Expansion Project Features and Costs

For the purposes of this report, the project identified as Alternative 1 in the Los Vaqueros Expansion Investigation EIS/EIR was evaluated as the example project formulation. This project would enlarge Los Vaqueros Reservoir from the planned 160 TAF to 275 TAF total capacity by raising the existing dam. In addition, it would include the features listed below. Project features are also illustrated on Figure 5-3.

Figure 5-3. 275 TAF Los Vaqueros Reservoir Expansion Project Inundation Area and Project Features

- Increase total Delta diversion capacity from 320 cubic feet per second (cfs) to 670 cfs. Five hundred cfs would come from modifying existing CCWD conveyance facilities to allow full concurrent operation of the Old River Intake and Pump Station (250 cfs) and Alternative Intake Project (250 cfs). The remaining capacity would come from a new 170 cfs Delta Intake and Pump Station. The new Delta Intake and Pump Station would be constructed on Old River south of the existing CCWD Old River Intake.
- Install a new Delta-Transfer pipeline connecting the new intake to the Transfer Facility parallel to the existing 320 cfs Old River pipeline. The new pipeline would have a capacity of 350 cfs for a combined conveyance capacity of 670 cfs between Delta intake facilities and the Transfer Facility.
- Install a pipeline parallel to the existing pipeline between the Transfer Facility and the Los Vaqueros Reservoir. The new Transfer-Los Vaqueros Pipeline would have a capacity of 670 cfs and would be used to fill the expanded reservoir and convey release flows to the South Bay connection of up to 470 cfs. The existing Transfer Pipeline would continue to be used to convey release flows to CCWD up to 400 cfs.
- Expand the existing Transfer Facility from a conveyance capacity of 200 cfs to 670 cfs and a storage capacity of 12 million gallons.
- Construct a new pipeline connecting the Transfer Facility to the SBA pump station at Bethany Reservoir with a capacity of up to 470 cfs.
- Construct a new power substation and related power conductors to provide power to the new intake and expanded Transfer Facility pump station.
- Construct new inlet and outlet pipelines at the reservoir and other ancillary reservoir facilities within the Los Vaqueros watershed (e.g., access roads, etc.).
- Replace and enhance recreational facilities that would be within the proposed inundation area.

New parallel pipelines are proposed in locations where the capacity of existing pipelines would be enlarged. Installing parallel pipelines has multiple benefits over replacing the existing pipelines, including decreased construction cost, increased operational flexibility, and the need to maintain service to CCWD during construction of the reservoir expansion. Two pipelines, rather than one larger pipeline, also provide redundancy in the event of emergencies and enable partial shutdowns for maintenance activities. A single pipeline is proposed for the South Bay connection. Because no pipeline exists in this location currently, installing a single pipeline will minimize environmental impacts and construction costs.

As calculated for the Draft EIS/EIR in 2009, the estimated capital cost for the facilities described above is $985 million. This cost estimate includes construction costs ($435 million), design and construction management ($170 million), land acquisition and mitigation ($25 million), and unlisted items and contingency ($355 million), and is escalated to mid-point of construction (assumed to be 2014) using an assumed 4% total cost of money.

Example 275 TAF Los Vaqueros Reservoir Expansion Project Operations

The expanded reservoir would be operated in coordination with the SWP and CVP to provide environmental benefits in the Delta and water supply reliability for San Francisco Bay Area water users. Improved fish screens would be used to divert and deliver a major portion of the Delta water supply for South Bay water agencies through the expanded Los Vaqueros system and the South Bay connection. This operation would replace the existing deliveries to these agencies through the CVP and SWP Delta export pumps. In addition, the expanded storage in Los Vaqueros Reservoir would be used to store available flows in the Delta that occur when water is abundant, and then release the stored water at later times when the stored water is most needed. This would provide water supply reliability to Bay Area water agencies that have recently had available supplies reduced due to new environmental restrictions imposed on current Delta operations, and that could also face water supply shortages in future droughts. Figure 5-4 depicts how the multiple components of the Los Vaqueros Reservoir Expansion Project combine to create substantial improvement and flexibility for fish protection, environmental water management, and Bay Area water supply reliability.

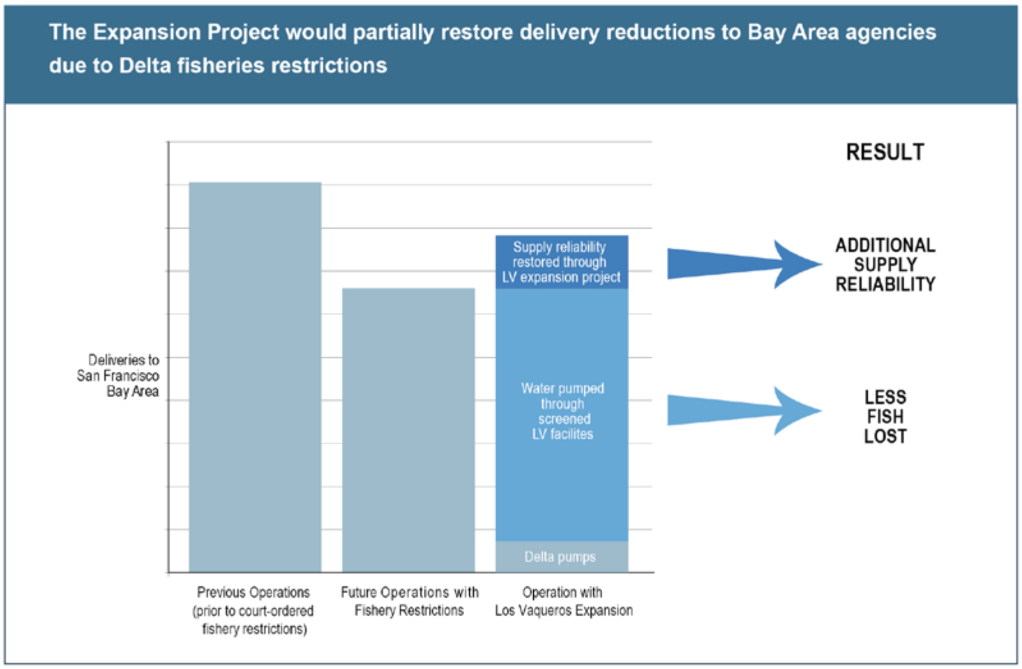

Figure 5-4. Representation of How the Multiple Components of the Los Vaqueros Expansion Investigation Combine to Achieve Project Benefits

Example 275 TAF Los Vaqueros Reservoir Expansion Project Benefits

This section describes the results of modeling conducted for the example 275 TAF Los Vaqueros Reservoir and summarizes potential project benefits, including public and non-public benefits based on guidance from the 2009 Comprehensive Water Package. A discussion of benefits of the example project is presented below according to whether the benefit would be shared by the public at large, or would be limited to a smaller group of beneficiaries. Environmental benefits are considered public, as are benefits that increase emergency preparedness. Improvements in water supply reliability for specific groups of water users are considered local, or non-public, benefits. Potential benefits of the example project are presented in Table 5-1 and illustrated in Figure 5-5.

Table 5-1. Summary of Potential Benefits for the Example 275 TAF Los Vaqueros Reservoir Expansion Project Formulation

Potential Benefits	Description	Metrics	Units	Long Term Average	Driest Periods Average
Public Benefits					
Ecosystem					
Refuge Supply	Provides Water Supply for South-of-Delta Refuges	Change in deliveries	TAF/Year	NA	NA
Fish Protection	Enables reductions in exports through Banks and Jones Pumping Plants with no water supply impacts	SF Bay Area deliveries made from storage to reduce spring diversions from Delta (Los Vaqueros no-diversion period)	TAF/Year	6	1
Fish Protection	Enables reductions in exports through Banks and Jones Pumping Plants with no water supply impacts	SF Bay Area diversions made through improved fish screens (Not including Los Vaqueros no-diversion period)	TAF/Year	147	86
Emergency Preparedness					
Emergency Storage	Improves Emergency Water Supply for water users in the SF Bay Area	Change in average storage available for delivery to local agencies in an emergency	TAF	15	2
Other Local Benefits					
Water Supply					
Reliability	Improves Water Supply Reliability for SF Bay Area SWP/CVP contactors	Change in deliveries	TAF/Year	7	2

CVP	=	Central Valley Project	SF	=	San Francisco
Delta	=	Sacramento-San Joaquin Delta	SWP	=	State Water Project
NA	=	not applicable	TAF	=	thousand acre-feet

Notes: [1] Long Term is the average quantity for the period of Oct 1922 - Sep 2003.

[2] Driest Periods is the average quantity for the combination of periods of May 1928 - Oct 1934, Oct 1975 - Sep 1977, and Jun 1986 - Sep 1992.

Public Benefits

The example project formulation could provide public benefits, including ecosystem improvements, emergency storage, and recreation, as described in the following sections.

Ecosystem Improvements

Fish protection benefits result from improved fish screening through state-of-the-art positive barrier fish screens, application of a no-diversion period during the most critical times for fish, multiple intake locations to avoid fish, and added flexibility in timing the pumping curtailment at SWP and CVP Delta export facilities to provide greater fish benefits.

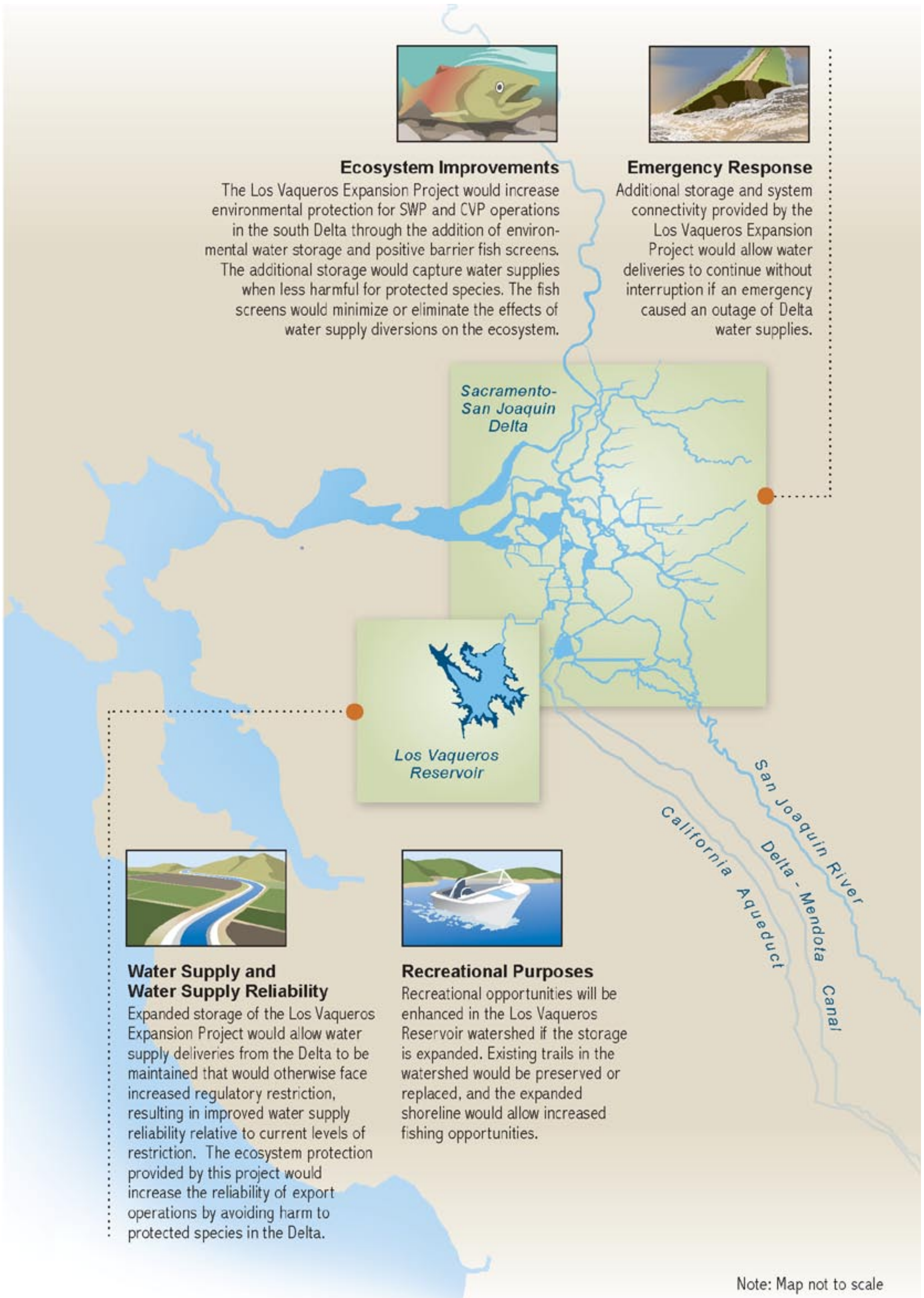

Figure 5-5. Summary of Potential Benefits of the Example 275 TAF Los Vaqueros Reservoir Expansion Project

Improved Fish Screening

The expanded Los Vaqueros system would only divert Delta water through state-of-the-art fish screens designed and operated to regulatory agency specifications. These fish screens would provide superior fish protection for diversions to meet South Bay water needs compared to the current diversions at the CVP and SWP export pumps. Diversions at the screened Los Vaqueros Reservoir system would have fewer impacts to fish than the same amount of water diverted at the SWP or CVP Delta pumps.

The locations of the reservoir's intakes in the Delta are also advantageous. Both the existing intake on Old River and the intake under construction on Victoria Canal are on the side of Delta channels, which helps enable their fish screens to perform effectively in preventing entrainment and impingement of fish swimming past compared to intakes that span a channel.

No-Diversion Period

The additional storage of the expanded reservoir would provide the operational flexibility to reduce or eliminate diversions at Los Vaqueros intakes during the most sensitive fish period without disrupting supplies. Existing Los Vaqueros Reservoir operations include a no-diversion period in the spring. During this period, CCWD water needs are met using stored water in Los Vaqueros Reservoir. Shifting the South Bay water agency diversions to the expanded reservoir system allows the application of this no-diversion period to approximately three times the current amount, while still maintaining deliveries.

Multiple Intake Locations

Water would be diverted to the expanded Los Vaqueros system through three separate Delta intakes. Multiple points of diversion and additional storage capacity, coordinated with SWP and CVP operations, would improve the flexibility of the state and federal water systems to respond to changing fishery conditions in the Delta to best protect fish.

Emergency Response/Storage

Increased stored water supplies would be available for delivery to Bay Area water agencies through the South Bay Connection or existing interties in the event of a Delta levee failure, earthquake, or other emergency.

Recreational Purposes

Recent visitor data shows that between 8,000 and 29,000 visitors come to the Los Vaqueros Watershed each year. Over 80 percent of the usage is for fishing. Other recreators visit for hiking on the 55 miles of trails and bicyclists and equestrians have the opportunity to use the multi-use trails. Other visitors utilize the interpretive center or take advantage of special educational or competitive sporting events. With the expansion project, recreation facilities affected by the inundation will be replaced and enhanced. The larger reservoir will provide additional opportunities for fishing from the shoreline and fishing piers. In addition, the existing marina will be expanded and more boats made available for use on the reservoir. The network of hiking trails will also be expanded.

Water Supply Reliability Benefits

Water supply reliability benefits result from restoring some Delta supplies lost due to current regulatory restrictions on SWP and CVP export pumping, storing water in wet years for use in dry years, and increasing available storage for emergencies.

The reservoir would continue to provide water quality benefits to CCWD. Operation of the project to provide water quality benefits for South Bay water agencies was not optimized for this analysis.

Delta Supply Restoration

Stored water supplies would be used to partially restore the delivery reductions to South Bay water agencies due to regulatory restrictions at the SWP and CVP Delta export pumps. The state-of-the-art fish screens and multiple intake locations would make deliveries less subject to uncertainties associated with curtailments at the CVP and SWP Delta export pumps. With additional storage, demands can be met with releases from the reservoir even when Delta export diversions are curtailed to protect Delta fisheries.

Dry Year Storage

The additional storage enables water to be carried over from year to year, increasing the amount of water available in dry years to South Bay water agencies and CCWD and reduces the need to purchase supplemental dry-year supplies.

Example 275 TAF Los Vaqueros Reservoir Expansion Project Benefits under an Uncertain Future

As stated previously in this report, future conditions are uncertain at this time and considered projects must be able to fulfill project objectives and provide benefits under variable future conditions. This section describes new modeling conducted for this report and presents new information on how an example expanded Los Vaqueros Reservoir could be coordinated with potential new Delta conveyance. The section also presents a qualitative analysis of the potential impacts of climate change on project benefits. The information presented in this section is for informational purposes only.

Potential Effect of New Delta Conveyance on Project Benefits

In light of the current fisheries decline in the Delta, and the related efforts to address protection of the Delta ecosystem, a future scenario with modified water conveyance facilities in the Delta was investigated. An example project formulation for the expansion of Los Vaqueros Reservoir was evaluated assuming that a conveyance facility would allow CVP and SWP diversions to be made in the south Delta or on the Sacramento River.

The physical features and operational goals of an expanded Los Vaqueros Reservoir are not anticipated to change with the development of additional water conveyance in the Delta. However, if the use of the additional conveyance causes changes in the Delta, such as altering the implementation of fishery regulations, or changing Delta water quality or Delta water supply availability, then the day-to-day operation of Los Vaqueros Reservoir could change, along with the level of benefit provided by the project. Benefits potentially provided by the Los Vaqueros Reservoir Expansion Project operated with new conveyance in the Delta are presented in Table 5-2.

The potential future Delta conveyance scenario that was evaluated would create benefits for Los Vaqueros Reservoir operations, by reducing the amount of time that fish protection flow standards limit the filling of the expanded portion of the reservoir. This effect allows increased filling of Los Vaqueros Reservoir, and increased capture of available water supply. The potential changes in project operations and benefits that would occur with the development of alternative conveyance in the Delta are discussed below for the same categories of public and other benefits presented above for the example project formulation.

Table 5-2. Summary of Potential Benefits for the Example 275 TAF Los Vaqueros Reservoir Expansion Project Formulation with New Delta Conveyance

Potential Benefits	Description	Metrics	Units	Long Term Average	Driest Periods Average
Public Benefits					
Ecosystem					
Refuge Supply	Provides Water Supply for South-of-Delta Refuges	Change in deliveries	TAF/Year	8	2
Fish Protection	Enables reductions in exports through Banks and Jones Pumping Plants with no water supply impacts	SF Bay Area deliveries made from storage to reduce spring diversions from Delta (Los Vaqueros no-diversion period)	TAF/Year	NA	NA
Fish Protection	Enables reductions in exports through Banks and Jones Pumping Plants with no water supply impacts	SF Bay Area diversions made through improved fish screens (Not including Los Vaqueros no-diversion period)	TAF/Year	115	82
Emergency Preparedness					
Emergency Storage	Improves Emergency Water Supply for water users in the SF Bay Area	Change in average storage available for delivery to local agencies in an emergency	TAF	41	16
Other Local Benefits					
Water Supply					
Reliability	Improves Water Supply Reliability for SF Bay Area SWP/CVP contactors	Change in deliveries	TAF/Year	8	13

CVP = Central Valley Project; SF = San Francisco
Delta = Sacramento-San Joaquin Delta; SWP = State Water Project
NA = not applicable; TAF = thousand acre-feet

Notes: [1] Long Term is the average quantity for the period of Oct 1922 - Sep 2003.

[2] Driest Periods is the average quantity for the combination of periods of May 1928 - Oct 1934, Oct 1975 - Sep 1977, and Jun 1986 - Sep 1992.

Ecosystem Improvements

Improved Fish Screening

The benefits of fish screens at the Los Vaqueros Reservoir intakes would still provide superior fish protection for diversions to meet South Bay water needs compared to the diversions at the CVP and SWP export pumps in the south Delta. However, the added flexibility of new conveyance could allow CVP and SWP to adaptively manage water diversions to protect Delta fish. The new conveyance is also assumed to include screened intakes, which would further improve fishery protection.

No-Diversion Period

Given the potential reductions in fish entrainment in the south Delta under a future conveyance scenario, the No-Diversion period may not provide the same level of benefit that it is thought to have under current conditions. In the example project formulation modeled for the possible future conveyance scenario, the No-Diversion period was implemented for CCWD but not for the South Bay water agencies. The environmental water storage in the expanded Los Vaqueros Reservoir was instead used to make deliveries to wildlife refuges in the San Joaquin Valley.

Refuge Supply

The increased storage in the expanded Los Vaqueros Reservoir could be used to capture and store water for San Joaquin Valley wildlife refuges, or other environmental water needs. This potential benefit is enhanced by the increased ability to fill Los Vaqueros Reservoir in the future conveyance scenario.

Multiple Intake Locations

Multiple intake locations for Los Vaqueros Reservoir would still provide protection for Delta fish. The increased flexibility of CVP and SWP intake facilities would increase this benefit.

Emergency Storage

The increased stored water supplies in the expanded Los Vaqueros Reservoir under the future conveyance scenario would directly improve the potential for the expansion project to deliver emergency water supply to Bay Area water agencies through the South Bay Connection or existing interties in the event of a Delta levee failure, earthquake, or other emergency.

Recreational Purposes

Public recreational opportunities at the Los Vaqueros watershed would not be affected differently by the future conveyance scenario.

Water Supply Reliability Benefits

Delta Supply Restoration

Water supply reliability benefits designed to restore some Delta supplies lost due to current regulatory restrictions on SWP and CVP export pumping would not be necessary in the future conveyance scenario that was evaluated; the Bay Area deliveries of CVP and SWP water supply are fully restored by the conveyance scenario.

Dry Year Storage

The increased potential to fill and deliver water from the expanded Los Vaqueros Reservoir in this scenario creates an improved potential for storing water in wet years for use in dry years, and substantially improves the dry year deliveries to Delta water users in the San Francisco Bay Area.

Potential Effect of Climate Change on Project Benefits

With respect to the potential effects of climate change, the example project increases the flexibility of local and regional water supply systems to adapt to changes in water supply availability. Increasing water storage capacity and flexibility to adjust the timing and location of water diversion from the Delta improves the ability of local, regional, and state water managers to adjust water supply operations to respond to potential changes in water supply availability as well as to respond to changing environmental conditions in the Delta. Additional studies may be performed as new information and analytical tools become available. Based on current levels of information on climate change, the following climate-related effects may occur that affect the operation of Los Vaqueros Reservoir:

- Higher temperatures will decrease Sierra snowpack storage, changing runoff timing, intensity, and duration. This will affect Delta water quality and the quantity and timing of available water supply in the Delta, which would require shifts in the timing of filling and releases from Los Vaqueros Reservoir.

- Sea-level rise will continue, and may interact with the changes in runoff to further perturb Delta salinity and available water supply. The filling and releases from Los Vaqueros Reservoir would be modified to match the changing window of available water supply.
- Higher temperatures will likely increase demand for water supply in California, including the Bay Area. Increased demands in the heat of summer will correspond to a water supply that is increasingly concentrated in the winter, due to changing runoff patterns. The portion of Los Vaqueros Reservoir that is drained and refilled each year will increase to maintain water supply reliability in the new climate conditions.

The climate change analysis performed to date indicates that additional water supply storage in Los Vaqueros Reservoir will be beneficial, and will help reduce the impacts of climate change on water users served by the reservoir. This issue will continue to be studied, and updated analyses will be used to inform future decisions about reservoir design.

Los Vaqueros Reservoir Expansion Project Environmental Effects

While the project is intended to provide benefits in the areas of fishery protection in the Delta, Bay Area water supply reliability, and Bay Area drinking water quality, its implementation would result in some short-term and long-term impacts to the environment. The environmental impacts associated with the project alternatives can be generally categorized as follows: project construction; facility siting/footprint; project operations; and climate change. These potential impacts are analyzed fully and discussed in detail in the EIS/EIR prepared for the project. They are discussed briefly below.

Construction

Most environmental impacts identified for the project would be associated with project construction; these impacts would occur for up to three years and would cease once project construction is completed. Construction activities generate impacts such as noise, dust, indirect habitat disruption, temporary effects on agricultural activities, construction traffic and access disruption, and increased potential erosion and related water quality issues. The EIS/EIR identifies feasible mitigation measures to reduce all construction impacts to less than significant levels.

Facility Siting/Footprint

Facility siting or footprint effects are the permanent effects that result from locating a facility on a specific site and removing or altering what was on the site previously. These types of impacts include conversion of farmland to non-agricultural uses, and effects on biological resources and habitats, cultural resources, visual resources, or other land uses as well as the potential for increased exposure to hazards. In most cases, feasible mitigation measures have been identified to reduce these significant effects to less than significant levels.

Expanding the reservoir from 160 TAF to 275 TAF would increase the area of reservoir inundation by approximately 600 acres, from 1,900 acres to 2,500 acres. The expanded reservoir would inundate existing habitat for biological resources, including various sensitive plant and animal species; inundation primarily would affect grassland habitat but also some oak woodland, scrub, and wetland habitats. The effects of reservoir expansion on biological resources could for the most part be mitigated to less than significant levels through implementation of a habitat compensation and enhancement program that would preserve, restore, and enhance habitats of the type affected.

Dam modification and reservoir expansion would also affect cultural resources; mitigation measures have been identified to reduce these effects to less than significant levels. Relocation of existing recreation facilities and the addition of new recreation facilities proposed under all alternatives would result in relatively small footprint effects on habitats within the watershed.

Construction of the new Delta Intake and Pump Station would result in loss of up to 22 acres of farmland that is designated as important farmland by the state. The entire area along Old River is designated as such, thus the impact to this farmland is unavoidable. Mitigation would be performed to reduce this impact to less than significant. Construction of new pipelines would result in only very limited footprint impacts.

Climate Change

The Final EIS/EIR examines the potential for the project to increase greenhouse gas emissions, which in turn would contribute to global climate change effects. As a global concern, increases in greenhouse gases contribute to cumulative impacts, rather than constituting a direct impact associated with a single project. The Final EIS/EIR also reviews changes in water supply availability, sea level rise, and the potential for increased flooding caused by climate change to assess how the project might affect or be affected by these environmental changes.

Project construction and operation would result in increased greenhouse gas emissions. Construction emissions would be short-term, ceasing after three years upon project completion. Greenhouse gas emissions associated with project operation would result primarily from the purchase and use of additional electrical energy to support water diversion and delivery pumping through the expanded Los Vaqueros Reservoir system. The increase in water diversion and delivery pumping proposed under the project could be partially offset by reductions in water pumping elsewhere, specifically through the state and/or federal Delta water export systems. The project will incorporate features designed to minimize energy consumption and greenhouse gas emission.

Chapter 6 Shasta Lake Water Resources Investigation

This section describes the feasibility of enlarging Shasta Lake. The information presented in this chapter has been summarized from the Shasta Lake Water Resources Investigation (SLWRI) Plan Formulation Report (PFR) (Reclamation, 2007) (See Box 6-1 for a list of acronyms and abbreviations used in this section). This section also summarizes new information for the SLWRI provided by the Bureau of Reclamation (Reclamation) that reflects recent water management changes, including the 2008 US Fish and Wildlife Service (USFWS) and 2009 National Marine Fisheries Service (NMFS) Biological Opinions (BO), and effects of proposed Sacramento-San Joaquin Delta (Delta) habitat conservation and conveyance actions and climate change.

Study Area and Project Location

Shasta Dam and Lake are on the upper Sacramento River in Northern California (See Figure 6-1). Shasta Dam is located about 9 miles northwest of the city of Redding, and the dam and entire reservoir are in Shasta County. At full pool, Shasta Lake stores 4.55 million acre-feet (MAF), covers an area of about 29,500 acres, and has about 400 miles of shoreline. The reservoir manages runoff from about 6,420 square miles of watershed. Shasta Lake delivers about 55% of the total annual water supply developed by the Central Valley Project (CVP). The Shasta Dam and Lake Project was constructed as an integral part of the CVP. It is operated to provide for the management of flood water; storage of winter runoff for irrigation in the Sacramento and San Joaquin valleys, municipal and industrial (M&I) water supply, maintenance of navigation flows, and protection and conservation of fish in the Sacramento River and Delta; and generation of hydroelectric energy.

The primary study area (Figure 6-1) for the SLWRI is Shasta Dam and Lake; lower reaches of inflowing rivers and streams, including the Sacramento River, McCloud River, Pit River, and Squaw Creek; and the Sacramento River downstream to about the Red Bluff Diversion Dam (RBDD). The RBDD was chosen as the downstream boundary of the primary study area because it is the point at which releases from Shasta Dam begin to have a negligible effect on Sacramento River water temperatures, and the river landscape changes to a broader, alluvial stream system.

Modification of Shasta Dam has of the potential to influence other resource programs and projects in the Central Valley. An extended study area primarily encompasses the following:

- Sacramento River downstream from the RBDD, including parts of the American River basin
- Delta, including parts of the lower San Joaquin River
- Water service areas of the CVP and State Water Project (SWP) that may be affected by changes at Shasta Dam and Lake

Box 6-1. Chapter 6 Acronym and Abbreviation List

AF	acre-feet
BO	Biological Opinion
CALFED	CALFED Bay-Delta Program
CP	comprehensive plan
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
Delta	Sacramento-San Joaquin Delta
^{o}F	degrees Fahrenheit
M&I	municipal and industrial
MAF	million acre-feet
NA	not applicable
NMFS	National Marine Fisheries Service
PFR	Plan Formulation Report
RBDD	Red Bluff Diversion Dam
Reclamation	United States Bureau of Reclamation
RPA	Reasonable and Prudent Alternative
RV	recreational vehicle
SLWRI	Shasta Lake Water Resources Investigation
SWP	State Water Project
TAF	thousand acre-feet
TCD	temperature control device
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WRC	Water Resources Council

Project Objectives

Major water and related resources problems, needs, and opportunities were identified in the primary study area. These include anadromous fish survival, water supply reliability, and other resources needs, as summarized below. The problems and needs serve as the basis for the SLWRI planning objectives. A detailed explanation of the problems, needs, and opportunities for the SLWRI can be found in the SLWRI PFR.

Anadromous Fish Survival

Chinook salmon have declined in the Central Valley due to a number of environmental factors. Key factors affecting Chinook salmon abundance in the Sacramento River is adequate water temperature and flow, especially in dry and critically dry years. Other factors contributing to the decline of this species include loss of historic spawning areas and suitable rearing habitat, water diversions from the Sacramento River, reduction in suitable spawning gravels, fluctuations in river flows, toxic acid mine drainage, unnatural rates of predation, and fish harvests. Various federal, state, and local projects are addressing each of the aforementioned contributing factors. Recovery actions range from changing the timing and magnitude of reservoir releases to changing the temperature of released water. In addition to flow requirements, structural changes have been made at Shasta Dam to change the temperature of released water, such as construction of the temperature control device (TCD), which was completed in 1997. Despite these steps, the need for additional effective actions continues for the Sacramento River, particularly upstream from the RBDD.

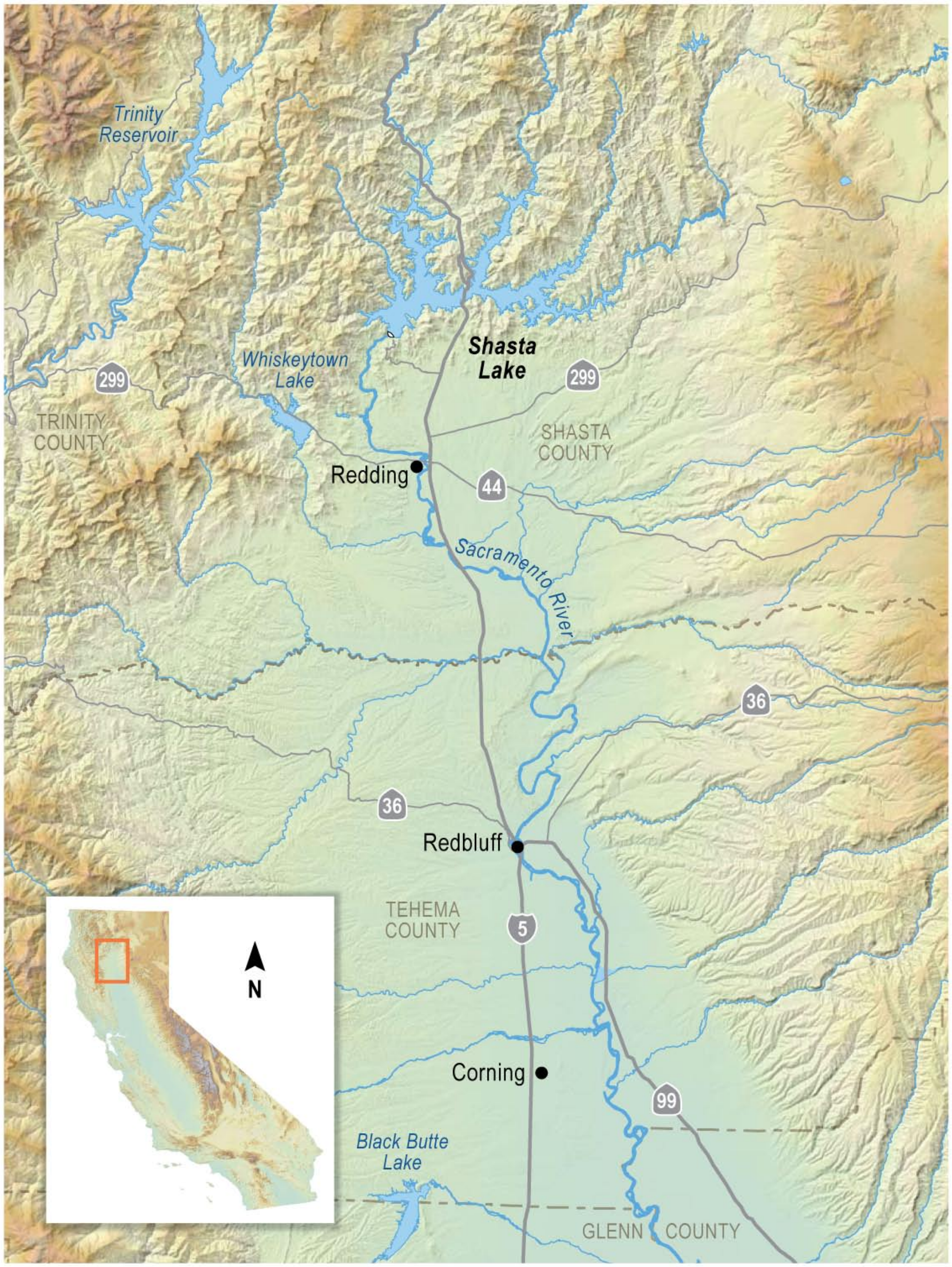

Figure 6-1. Location of Shasta Dam and Lake and SLWRI Primary Study Area

Water Supply Reliability

Demand for water in California exceeds available supplies. As the population of California continues to grow, the demand for adequate water supplies will become more acute. The ability to maintain a healthy and vibrant industrial and agricultural economy will become increasingly difficult. Climate change may result in more variable precipitation, less snowfall, and earlier snowmelt that may exacerbate demands on available water supplies in the future. As owner and operator of the CVP, Reclamation identified the need to increase the reliability of CVP water deliveries to its water contractors for agricultural, M&I, and environmental purposes, particularly during dry and critically dry water years. As one of many efforts to improve the reliability of California's water supply, the SLWRI was established to evaluate the potential to improve water supply reliability primarily by modifying Shasta Dam and enlarging Shasta Lake.

Opportunities

Other identified problems, needs, and opportunities include growing demands for existing and new energy sources in California; the need for restoring environmental values in the Shasta Lake area and downstream along the Sacramento River; the need for additional flood protection along the upper Sacramento River; opportunities for improving water quality conditions downstream of Shasta Dam in the Sacramento River and Delta; and the need to preserve and increase recreation opportunities in the north Sacramento Valley.

Planning Objectives

Two primary and five secondary planning objectives were developed based upon identified water resources problems, needs, and opportunities, and information contained in the CALFED Bay-Delta Program Record of Decision (CALFED, 2000b):

Primary Planning Objectives

- Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from the RBDD
- Increase water supplies and water supply reliability for agricultural, M&I, and environmental purposes to help meet future water demands, with a focus on enlarging Shasta Dam and Lake

Secondary Planning Objectives

- Preserve and restore ecosystem resources in the Shasta Lake area and along the upper Sacramento River
- Reduce flood damages along the Sacramento River
- Develop additional hydropower capabilities at Shasta Dam
- Preserve and increase recreation opportunities at Shasta Lake
- Preserve and improve water quality conditions in the Sacramento River downstream of Shasta Dam and the Delta

Project Formulation and Initial Alternatives

A No-Action Alternative and five comprehensive plans (CP) were developed based on the above planning objectives.

During alternative formulation, over 60 potential measures were developed based on information from previous studies, programs, and projects to address the primary and secondary planning objectives and satisfy the other planning constraints, considerations, and criteria. These measures were reviewed and other measures were developed during study team meetings, field inspections, environmental scoping, and outreach for the SLWRI. Measures that were believed to best address the objectives of the SLWRI were retained and combined into initial plans believed to represent the range of potential alternatives that best addressed the planning objectives.

Based on initial plans, structural alternatives were formulated focusing on different dam raise heights within the range of 6.5 to 18.5 feet. Although higher dam raises are technically and physically feasible, 18.5 feet is the largest dam raise that would not require extensive and very costly reservoir area relocations, such as moving the Pit River Bridge, I-5, and the Union Pacific Railroad. While any dam raise options up to 18.5 feet are possible, three dam raises—6.5-feet, 12.5-feet, and 18.5-feet—adequately represent the extent of benefits, impacts, and costs associated with any raise within the 6.5-foot to 18.5-foot range.

The next step in developing the alternatives was to formulate comprehensive plans focusing on anadromous fish survival, water supply reliability, and the other objectives. The CPs were formulated to represent a comprehensive and reasonable balance between the two primary objectives, while also including components to address the secondary objectives, as appropriate. The following CPs are under consideration:

- **Comprehensive Plan 1 (CP1) – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability** – CP1 focuses on increasing water supply reliability and improving anadromous fish survival with benefits to other resources through a 6.5-foot raise of Shasta Dam and 256,000 acre-feet (AF) enlargement of Shasta Lake.
- **Comprehensive Plan 2 (CP2) – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability** – As with CP1, this CP focuses on increasing water supply reliability and improving anadromous fish survival with benefits to other resources through a 12.5-foot raise of Shasta Dam and 443,000 AF enlargement of Shasta Lake. A dam raise of 12.5-feet represents a midpoint between the likely smallest dam raise considered (6.5-foot dam raise) and the largest practical dam raise (18.5-foot dam raise).
- **Comprehensive Plan 3 (CP3) – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability** – CP3 was formulated as the greatest practical enlargement of Shasta Dam and Lake and focuses on increasing water supply reliability and improving anadromous fish survival with benefits to other resources through an 18.5-foot raise of Shasta Dam and 634,000 AF enlargement of Shasta Lake.
- **Comprehensive Plan 4 (CP4) – 18.5-Foot Dam Raise, Anadromous Fish Focus** – Similar to CP3, CP4 was formulated the greatest practical enlargement of Shasta Dam and Lake (18.5-foot raise of Shasta Dam); however, CP4 focuses on improving anadromous fish survival with some benefits to water supply reliability and other resources. Of the 634,000 AF of increased storage space, close to 60% (378,000 AF) would be dedicated to increasing the cold-water supply for anadromous fish purposes.
- **Comprehensive Plan 5 (CP5) – 18.5-Foot Dam Raise, Combination Plan** – CP5 is a combined plan similar to CP3 that also includes features for ecosystem restoration and additional recreation facilities around Shasta Lake. Formulation of specific environmental restoration features and increased recreation components is not yet complete but will be included in the draft Feasibility Report.

Each of the CPs were evaluated against the specified planning objectives and four criteria of completeness, effectiveness, efficiency, and acceptability, as identified in the federal planning guide *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC, 1983). It was found that at this stage of SLWRI planning, each CP ranked similarly. All of the plans were found to meet the completeness criterion. All of the plans would accomplish the planning objectives as formulated, and are economically feasible. Each of the CPs is estimated to be complete, appears to be effective in achieving its intended objectives, and is economically feasible. All plans would be cost effective under future conditions when the reliability of sufficient supplies of water diminishes. All plans are estimated to meet the acceptability criteria, although continued coordination of the plans is necessary among other agencies and public interests.

All of the CPs would increase water supply reliability by increasing firm water supplies for irrigation and M&I purposes primarily during drought periods. In addition, each CP would increase the ability of Shasta Dam to meet target flow requirements, make cold-water releases and regulate water temperature in the upper Sacramento River, primarily in dry and critically dry years. All of the CPs include features to maintain the existing recreation capacity at Shasta Lake and would provide for modernized recreation facilities. Increasing the size of Shasta Dam and Reservoir would also result in the ability to increase hydropower generation at Shasta Dam generating facilities, and would provide incidental flood protection benefits along the Sacramento River.

Example 18.5-Foot Shasta Dam Raise Project Formulation Project Features and Costs

This section describes an example 18.5-foot Shasta Dam raise project formulation that focuses on a broad range of benefits. The example project formulation is most similar to CP5 from the PFR. Facilities and costs are generally the same as presented in the PFR; however, operations have been modified to account for new regulations in the Sacramento River and the Delta.

Example 18.5-Foot Shasta Dam Raise Project Formulation Project Features

The example 18.5-foot Shasta Dam raise project formulation would address both the primary and secondary planning objectives. The example project formulation focuses on increased water supply reliability and improving anadromous fish survival, while also enhancing Shasta Lake area and upper Sacramento River environmental resources, and providing increased recreation opportunities (formulation of specific environmental restoration features and increased recreation components is not yet complete but will be included in the draft Feasibility Report). The additional storage created by the 18.5-foot dam raise would be used to increase water supply reliability and improve the ability to meet temperature and flow objectives for anadromous fish. The capacity of the reservoir would increase by 634,000 AF to a total of 5.19 MAF and the existing TCD would be extended to achieve efficient use of the expanded reservoir. Table 6-1 summarizes the physical features associated with an 18.5 foot dam raise. Figure 6-2 illustrates the inundation area of an enlarged Shasta Lake and major project features.

Table 6-1. Summary of the Example 18.5-foot Shasta Dam Raise Project Features

Project Feature	Details
Dam and Appurtenant Structures	
Main Dam	Remove existing structures on Dam Crest Raise Dam Crest 18.5-feet using mass concrete and structural concrete placements New dam crest will have same surface area and similar features as existing dame crest
Full Pool Height Increase (feet)	20.5
Elevation of Full Pool (feet)	1,087.50
Capacity Increase (AF)	634,000
Wing Dams	Left wing-dam raised 18.5 feet Extend reinforced-concrete core wall to meet dam crest Rock-fill placed downstream from core wall Construct new upstream parapet wall for flood protection Replace gantry crane
Spillway	Raise crest Raise and extend piers downstream to support new spillway bridge Replace 3 drum gates with 6 sloping wheel gates
Spillway Crest Elevation (feet)	1,060
Temperature Control Device	Raise/modify controls
Pit 7 Dam	Minor modifications to the powerhouse
Reservoir Area Dikes and Railroad Embankments	Construct 7 new dikes
Relocations	
Roadways	Modify or relocate 30 road segments, approximately 6 miles total
Vehicle Bridges	Relocate 4 bridges Modify 1 bridge
Railroad Bridges	Modify 3 bridges
Recreation Facilities	Modify or replace portions of existing recreation facilities around Shasta Lake including, marinas, boat ramps, resorts, campgrounds/day use areas/RV sites, USFS facilities, and trails
Utilities	Relocate inundated utilities Construct wastewater treatment facilities
Ecosystem Restoration	Construct shoreline fish habitat around Shasta Lake Augment spawning gravel in the upper Sacramento River Restore riparian habitat and floodplain in the upper Sacramento River Enhance aquatic habitat in tributaries to Shasta Lake to improve fish passage

AF = acre-feet

RV = recreational vehicle

USFS = United States Forest Service

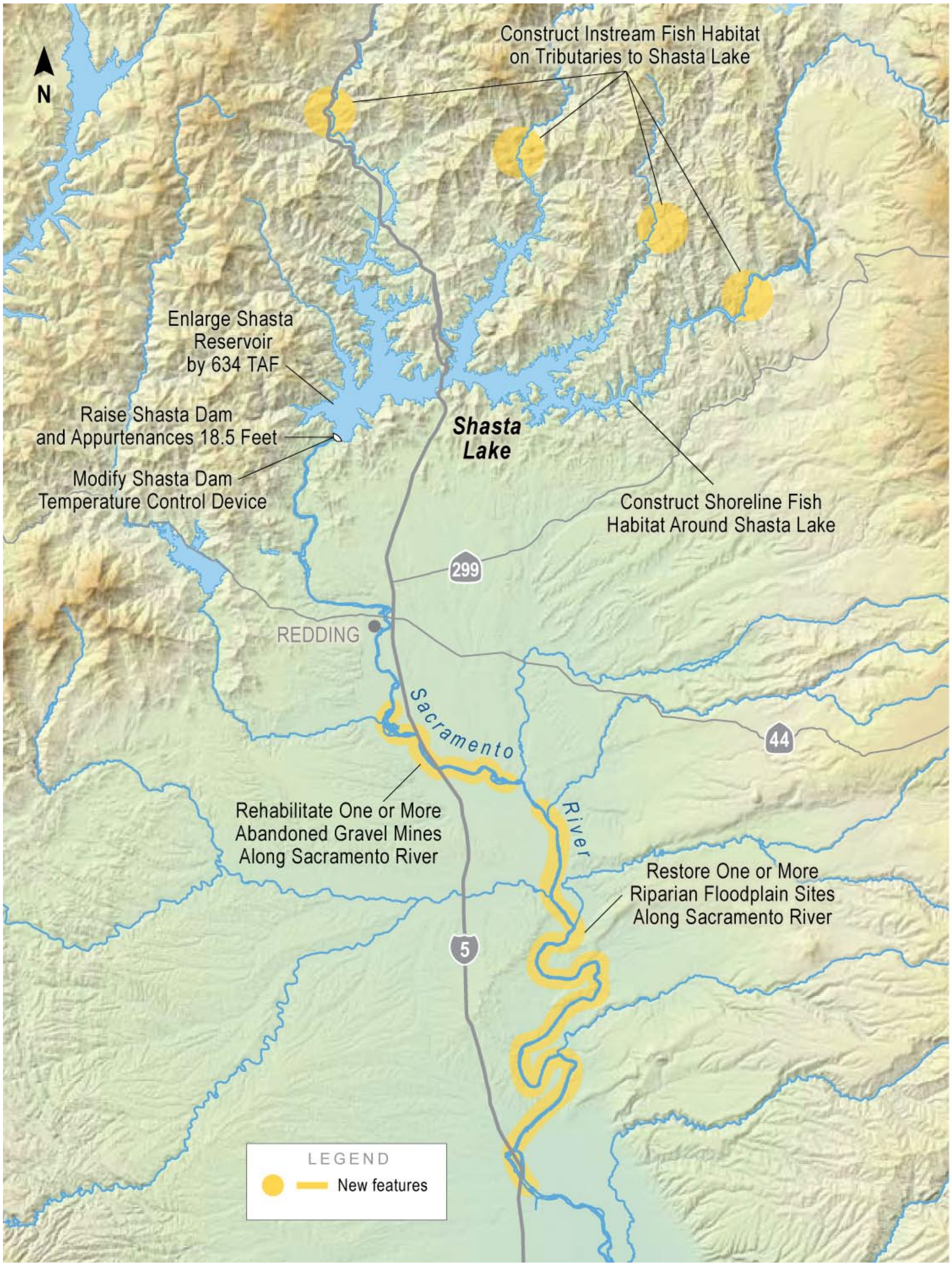

Figure 6-2. 18.5-foot Shasta Dam Raise Project Features

As indicated in Table 6-1, the example project would include measures to address ecosystem restoration and enhanced recreation in the Shasta Lake area. Ecosystem restoration features under development for the example project include (1) restoring resident fish habitat in Shasta Lake, (2) restoring fisheries and riparian habitat at several locations along the lower reaches of the upper Sacramento River and other tributaries to Shasta Lake, (3) augmenting spawning gravel in the Sacramento River, and (4) restoring riparian and floodplain habitat in the Sacramento River. The example project would also include features to avoid and offset adverse effects to existing recreation facilities at Shasta Lake, as well as construct additional facilities for recreation within the vicinity of Shasta Lake. Restoration and recreation features are still under development and will not be fully identified until the draft Feasibility Report.

Example 18.5-Foot Shasta Dam Raise Project Formulation Project Costs

The estimated capital cost for an example 18.5-foot Shasta Dam raise project formulation is $942 million (presented in October 2006 dollars). Project cost estimates are based on appraisal-level engineering studies for the various facilities and are subject to change as the feasibility study progresses.

Example 18.5-Foot Shasta Dam Raise Project Formulation Operations

Major operational priorities of this example project formulation are to improve the survivability of anadromous fish by providing increased coldwater supplies and improve the reliability of water supply to water contractors and environmental purposes. Under the example plan, the enlarged Shasta Dam can be operated in a variety of ways. The increase in cold-water pool resulting from an 18.5-foot raise of Shasta Dam would allow Shasta Reservoir operations to provide not only a more reliable source of water during critical and dry water years, but also provide more cool water for release into the Sacramento River for anadromous salmonids, as water temperatures that are too high can be detrimental to the various life stages of salmon. Elevated water temperatures can negatively impact spawning adults, egg maturation and viability, and preemergent fry, significantly diminishing the resulting ocean population and next generation of returning spawners.

The enlarged dam and reservoir would be operated for water supply to the CVP and SWP under existing operational guidelines. Temperature operations would be controlled by extending the existing TCD for efficient use of the expanded coldwater pool. Water operations modeling performed for this report was based primarily on existing and future operational constraints. Unlike previous modeling conducted under the SLWRI, water operations modeling for this report included CVP and SWP operational conditions described in the 2008/2009 BOs, which included reasonable and prudent alternatives (RPA) that impact water management operations at Shasta Dam.

The goal of the RPAs recommended by NMFS is to manage water temperatures in the upper Sacramento River to protect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Southern distinct population segment of the North American green sturgeon. Actions are focused on reducing the risk of temperature effects to egg incubation in the upper river, especially to winter-run and spring-run spawning below Shasta Dam. The RPAs include a new year-round storage and temperature management program for the upper Sacramento River, particularly release schedules for Keswick Dam/Shasta Dam, and procedures based on end-of-September storage targets for Shasta Lake.

Example 18.5-Foot Shasta Dam Raise Project Formulation Benefits

This section presents new modeling conducted for an example formulation of an 18.5-foot Shasta Dam Raise that includes new operating criteria recommended by the NMFS and USFW BOs and summarizes potential project benefits. This section describes how the example 18.5-foot Shasta Dam raise project formulation would meet primary objectives and achieve project benefits, including public benefits. This presentation distinguishes between public and non-public benefits based on guidance from the 2009 Comprehensive Water Package. According to the 2009 Water Package, public benefits may include ecosystem improvements, water quality improvements, flood control benefits, emergency response, and recreation. Water supply reliability and water quality benefits for M&I and agricultural users and hydropower generation are assumed to be non-public benefits.

The information presented in this section is for informational purposes only. The example project formulation presented in this section was formulated to fulfill a wide variety of project benefits and may not represent the most technically and/or economically feasible alternative considered in past and/or future feasibility study reports and environmental documentation, and should not be considered as a preferred alternative.

Potential benefits are illustrated in Figure 6-3.

Public Benefits

The example 18.5-foot Shasta Dam raise project formulation could provide public benefits, including ecosystem improvements, water quality improvements, flood control benefits, and recreation, as described in the following sections.

Ecosystem Improvements

The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet temperature and flow objectives for anadromous fish. The example project formulation could increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures in the upper Sacramento River, and increase the ability to meet target flow requirements for anadromous fish, primarily in dry and critically dry years.

Cold water released from Shasta Dam significantly influences water temperature conditions on the Sacramento River between Keswick and Red Bluff. Raising Shasta Dam would increase the depth of the cold-water pool in Shasta Lake, resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperatures and density change). Table 6-2 provides recent modeling results illustrating how the example 18.5-foot Shasta Dam Raise project formulation can provide temperature benefits to the Sacramento River and increase coldwater pool in Shasta Lake.

Raising Shasta Dam could contribute to anadromous fish survival by increasing Reclamation’s ability to maintain suitable water temperatures in the Sacramento River and meet other legal and institutional requirements for instream flows and other water quality parameters. Increased Shasta storage could contribute to additional flow releases in the Sacramento River during critical periods for fish species.

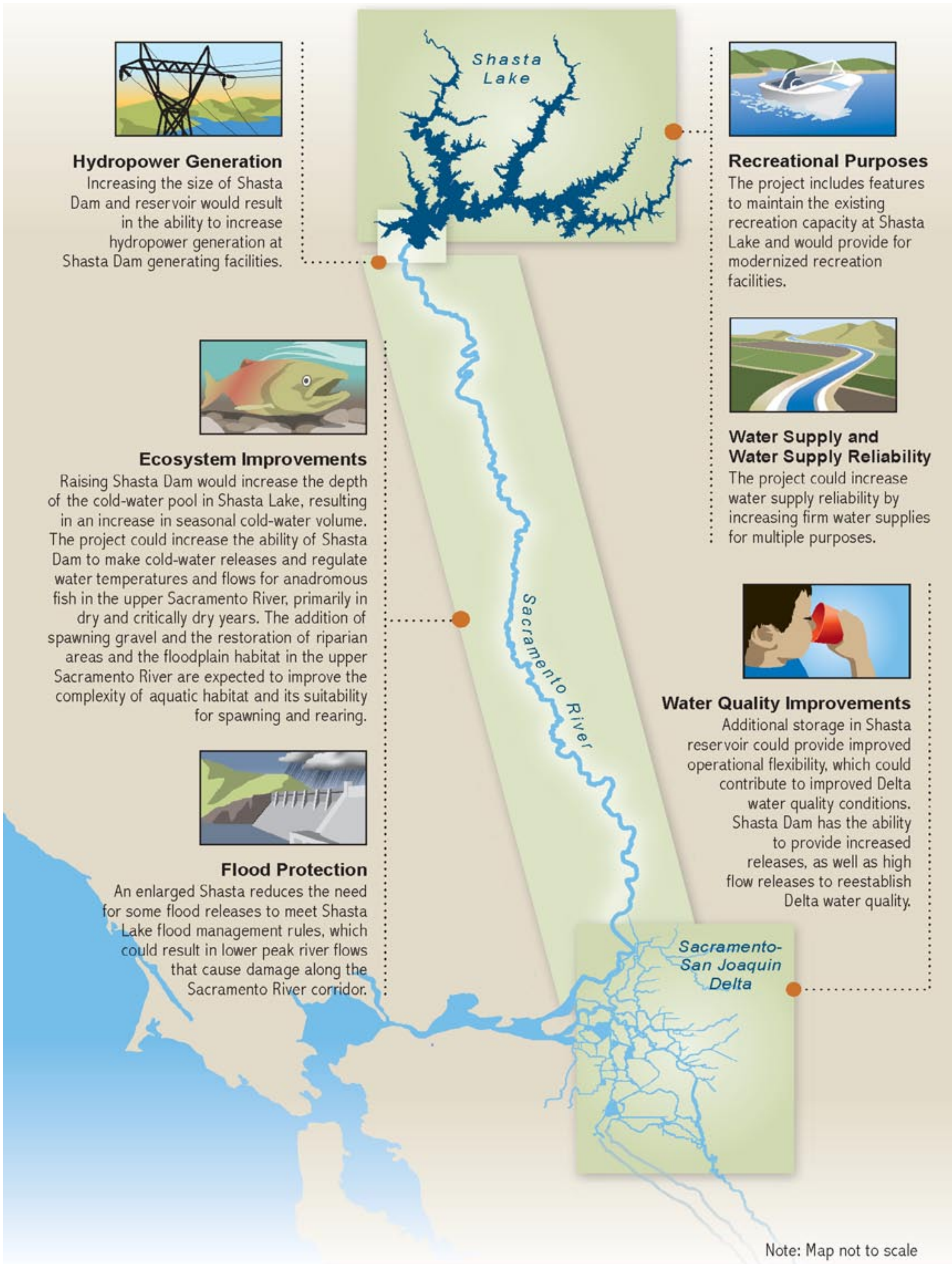

Figure 6-3. Summary of Potential Benefits of the Example 18.5-foot Shasta Dam Raise Project

Table 6-2. Potential Anadromous Fish and Ecosystem Restoration Benefits of the Example 18.5-foot Shasta Dam Raise Project Formulation

Potential Anadromous or Ecosystem Restoration Action/Target	Long-Term Average[1]	Driest Periods Average[2]
Change in Sacramento River Peak June-October Temperature at Balls Ferry (°F)	-0.61	-0.43
Change in Sacramento River Average June-October Temperature at Balls Ferry (°F)	-0.92	-0.64
Change in Sacramento River Peak June-October Temperature at Bend Bridge (°F)	-0.48	-0.44
Change in Sacramento River Average June-October Temperature at Bend Bridge (°F)	-1.37	-1.09
% of years meeting or exceeding the Balls Ferry Peak Temperature target of < 56°F (% improvement)	80 (+22)	NA
% of years with Shasta Lake End of September Storage greater than 2.2 MAF (% improvement)	84 (+4)	NA
% of years with Shasta Lake End of September Storage greater than 2.2 MAF with following End of April Storage Condition greater than 3.8 MAF (% improvement)	74 (+9)	NA
% of years with Shasta Lake End of September Storage greater than 3.2 MAF (% improvement)	57 (+35)	NA

°F = degrees Fahrenheit

MAF = million acre-feet

NA = not applicable

Notes: [1] Long-term average is the average for the period October 1922 to September 2003.

[2] Driest periods average is the average for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

Enlargement of Shasta Dam and Lake can also contribute to ecosystem restoration along the Sacramento River and in the Delta. Improvements to both water temperature and flows for Sacramento River aquatic species could be accomplished. In the upper Sacramento River, the addition of spawning gravel and the restoration of riparian areas and floodplain habitat are expected to improve the complexity of aquatic habitat and its suitability for spawning and rearing. Riparian areas provide habitat for a diverse array of plant and animal communities along the Sacramento River, including numerous threatened or endangered species. Riparian areas also provide shade and woody debris that increase the complexity of aquatic habitat and its suitability for spawning and rearing. Lower floodplain areas, river terraces, and gravel bars play an important role in the health and succession of riparian habitat.

In addition to the aforementioned ecosystem benefits, the example project formulation also includes benefits to ecosystem restoration around Shasta Lake. Ecosystem restoration around Shasta Lake includes improving shallow, warm-water habitat by installing artificial fish cover, such as anchored complex woody structures and boulders, and planting water-tolerant and/or erosion-resistant vegetation near the mouths of tributaries. The placement of manzanita brush structures near the Shasta Lake shoreline would enhance the diversity of structural habitat available for the warm-water fish species that occupy Shasta Lake. These improvements would help provide favorable spawning conditions, and juvenile fish leaving the tributaries would benefit from improved adjacent shoreline habitat. The lower reaches of perennial tributaries to Shasta Lake would be targeted for aquatic restoration because they provide year-round fish habitat. Native fish species require connectivity to the full range of habitats offered by Shasta Lake and its tributaries. Improved fish passage addresses the requirement to provide the access and/or barriers necessary for ecological conditions that support these native fish assemblages.

Water Quality Improvements

Additional storage in Shasta Reservoir would provide improved operational flexibility, which could contribute to improved Delta water quality conditions and Delta emergency response. Shasta Dam has the ability to provide increased releases, as well as, high flow releases to reestablish Delta water quality. Improved Delta water quality conditions could provide benefits for both water supply reliability and ecosystem restoration by potentially increasing Delta outflow during drought years, and reducing salinity during critical periods.

Flood Control Benefits/Flood Protection

The example project formulation would provide incidental flood protection benefits along the Sacramento River. Enlarging Shasta Dam and Reservoir could provide greater flexibility in flood control releases in the CVP/SWP system due to the potential for additional flood control space within Shasta Reservoir. A reduction in the need for releases to meet flood management rules in Shasta Lake could result in lower peak river flows that cause damage along the river corridor. While planning analysis on a monthly time step may not capture the operations in reaction to flood events, information suggests that flood management releases can be reduced by an average of 70 thousand acre-feet (TAF) per year, resulting in the potential reduction of flood damage and allowing the water supply to be conserved for subsequent use.

Recreational Purposes

The example project formulation includes features to maintain the existing recreation capacity at Shasta Lake and would provide for modernized recreation facilities and an enlarged lake surface area for water-based recreation in nearly all year types. Shasta Lake is one of the most visited recreation destinations in the state and region, given its large size, favorable climate, and easy access. Additional flexibility in managing the resource for recreation is an anticipated benefit of increased storage capacity.

Water Supply Reliability Benefits

The example project formulation could increase water supply reliability by increasing firm water supplies for irrigation and M&I purposes primarily during drought periods. This water supply increase could contribute to replacement of supplies redirected to other purposes in the Central Valley Project Improvement Act (CVPIA). Since the enactment of the CVPIA, 1.2 MAF of CVP yield have been dedicated and managed annually for the primary purpose of implementing the fish, wildlife, and habitat restoration purposes and measures authorized by the CVPIA.

The example project formulation would help reduce estimated future shortages by increasing the reliability of firm water supplies in dry periods by at least 71 TAF per year, and average annual yield by about 74 TAF per year.

Hydropower Generation

Increasing the size of Shasta Dam and Lake would result in higher water surface elevations in the reservoir, which would result in a net increase in the power generation at Shasta Dam facilities. Also, additional flows captured by the enlarged reservoir would pass through the hydropower generation facilities at both Shasta Dam and Keswick Dam. Updated analysis shows the capacity to increase power production by an average of 3.2% in dry years and by 2.6% overall. The net generation of the example project is positive and beneficial. Net generation accounts for both increased generation at Shasta Dam due to an enlarged reservoir and additional energy requirements required for pumping the increased water supplies to contractors.

Example 18.5-Foot Shasta Dam Raise Project Formulation Benefits Under an Uncertain Future

As stated previously in this report, future conditions are uncertain at this time and considered projects must be able to fulfill project objectives and provide benefits under variable future conditions. This section describes new modeling conducted for this report and presents new information on how an example enlarged Shasta Lake could be coordinated with potential new Delta conveyance. The section also presents a qualitative discussion of the potential impacts of climate change on project benefits. The information presented in this section is for informational purposes only. As stated previously, the example project formulation presented in this section was formulated to fulfill a wide variety of project benefits and may not represent the most technically and/or economically feasible alternative considered in past and/or future feasibility study reports and environmental documentation, and should not be considered as a preferred alternative.

Potential Effect of New Delta Conveyance on Project Benefits

This section presents how an example 18.5-foot Shasta Dam raise project could accomplish project objectives and provide benefits under future operation scenarios that include potential new Delta conveyance, as being studied by the Bay-Delta Conservation Plan and Delta Habitat Conservation and Conveyance Program. This section focuses on qualitative analysis conducted for ecosystem improvements, water supply reliability, and hydropower generation. Other benefit categories discussed above are not expected to change significantly with new Delta conveyance; however, further analysis will be conducted as the feasibility study progresses.

Ecosystem Improvements

As with the example project formulation without new Delta conveyance, raising Shasta Dam would increase the depth of the cold-water pool in Shasta Lake and result in an increase in seasonal cold-water volume. The example project formulation with or without new conveyance could increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures in the upper Sacramento River, and increase the ability to meet target flow requirement for anadromous fish, primarily in dry and critically dry years.

Table 6-3 provides recent modeling results illustrating how the example 18.5-foot Shasta Dam Raise project formulation under an operation that includes new Delta conveyance can provide temperature benefits to the Sacramento River and increase coldwater pool in Shasta Lake.

The success of the RPAs described in the 2008 USFWS and 2009 NMFS BOs depends on Reclamation’s ability to store enough water in Shasta Reservoir to develop a suitable cold-water pool volume to provide suitable water temperatures in the Sacramento River. In addition, tradeoffs exist between the use of new conveyance to address water supply reliability issues and the use of increased storage capacity to improve cold water pool and address temperature compliance performance measures. As with the example project formulation without new Delta conveyance the example project formulation provides additional ecosystem benefits in the upper Sacramento River and around Shasta Lake.

Table 6-3. Potential Anadromous Fish and Ecosystem Restoration Benefits of the Example 18.5-foot Shasta Dam Raise Project Formulation with New Delta Conveyance

Potential Anadromous or Ecosystem Restoration Action/Target	Long-Term Average[1]	Driest Periods Average[2]
Change in Sacramento River Peak June-October Temperature at Balls Ferry (°F)	-0.49	-0.51
Change in Sacramento River Average June-October Temperature at Balls Ferry (°F)	-0.41	-0.28
Change in Sacramento River Peak June-October Temperature at Bend Bridge (°F)	-0.39	-0.53
Change in Sacramento River Average June-October Temperature at Bend Bridge (°F)	-0.28	-0.26
% of years meeting or exceeding the Balls Ferry Peak Temperature target of < 56°F (% improvement)	57 (+18)	NA
% of years with Shasta Lake End of September Storage greater than 2.2 MAF (% improvement)	87 (+4)	NA
% of years with Shasta Lake End of September Storage greater than 2.2 MAF with following End of April Storage Condition greater than 3.8 MAF (% improvement)	73 (+5)	NA
% of years with Shasta Lake End of September Storage greater than 3.2 MAF (% improvement)	56 (+22)	NA

°F = degrees Fahrenheit

MAF = million acre-feet

NA = not applicable

Notes: [1] Long-term average is the average for the period October 1922 to September 2003.

[2] Driest periods average is the average for the combinations of periods May 1928 to October 1934, October 1975 to September 1977, and June 1986 to September 1992.

Water Supply Reliability Benefits

With new Delta conveyance, the example project formulation would help reduce estimated future shortages by increasing the reliability of firm water supplies in dry periods by at least 70 TAF per year, and average annual yield by about 85 TAF per year. Enlarged Shasta Lake conservation storage capacity allows the increased flexibility afforded by new Delta conveyance to be used to greater advantage in meeting water supply reliability goals. As with the existing Delta conveyance option, the benefit is achieved through the improved ability to capture and conserve inflows in wetter periods for use in prolonged dry periods.

Hydropower Generation

As with the existing Delta conveyance option, increasing the size of Shasta Dam and Lake would result in the ability to increase hydropower generation at Shasta Dam facilities. Additional releases of water for delivery benefits can be passed through the power plant, and analysis shows an overall capacity to increase power production by 2.5%.

Potential Effect of Climate Change on Project Benefits

Potential effects of climate change may include higher temperatures, less snowfall, earlier snowmelt, changes to precipitation amounts and timing, and changes to demands on available water supplies. It is unlikely that changes in snow levels would affect Shasta Reservoir as significantly as other Central Valley reservoirs because Shasta Reservoir is primarily filled by direct rainfall runoff, as opposed to snowmelt. Changes to the quantity and timing of rainfall are anticipated to have a greater effect on managing Shasta Lake operations under changing climate scenarios. The SLWRI has recommended further investigations into the identification of climate change effects on the CPs, including suggestions for applying watershed-scale hydrologic models that can provide more information on hydrologic consequences of precipitation changes.

Increased reservoir capacity has the potential to improve flexibility in managing water resources under the level of uncertainty created by climate change, particularly in reacting to impacts of precipitation amounts, timing, and intensity. This improved flexibility could be seen in several elements of targeted benefits. Changes in water management operations downstream and in the Delta could affect Shasta Reservoir operations. If precipitation increases, it may further enhance the benefits of increased reservoir capacity. The challenge of maintaining the balance between an adequate cold water pool and instream flow requirements in dry years will be greater under future conditions which are likely to include warming temperatures. Increased storage is anticipated to help provide better cold water conditions and increased flexibility in meeting flow requirements. Increased generation of hydropower as a result of enlarged storage capacity of Shasta Lake is recognized as a benefit in replacing other forms of energy generation that contribute to greenhouse gas emissions. Water supply reliability benefits of additional storage will be important to providing responses to changes in agricultural and municipal demands by water users.

Shasta Reservoir Enlargement Potential Environmental Effects

A draft Feasibility Report and Environmental Impact Statement disclosing environmental impacts resulting from the SLWRI is scheduled for public release in 2011. Environmental studies and evaluations are being conducted to determine the type and extent of potential environmental impacts anticipated.

All five CPs are expected to be similar in terms of their potential environmental effects. As mentioned above, the changes in temperature and flows are expected to have a beneficial impact on anadromous fish resources. Potential impacts on flow and stages of the upper Sacramento River from this plan are expected to be minimal. During most years, annual operations of Shasta Reservoir, and subsequent flows and stages in the Sacramento River, would be relatively unchanged. All potential noticeable changes in flows and stages would diminish rapidly downstream from RBDD.

It is anticipated that some of the adverse effects of the CPs would be temporary. The primary long-term impacts of the example project in the Shasta Lake area would be due to the increased water surface elevations and inundation area. General types of impacts include potential inundation of terrestrial and aquatic habitat, buildings, sections of paved and nonpaved roads, recreation facilities, and low-lying bridges. The scale of some adverse effects related to expanded construction areas associated with increased reservoir area is likely to be exacerbated by larger dam raises.

As part of the project planning and environmental assessment process, Reclamation will incorporate environmental commitments and best management practices to avoid or minimize potential effects. Reclamation has also committed to coordinate with applicable resource agencies during planning, engineering, design, construction, operation, and maintenance phases of the project. Reclamation will continue to coordinate with the State and potential non-federal sponsors to develop strategies to address potential impacts on the McCloud River (a reach protected by the state Wild and Scenic River Act) and with tribal groups on potential impacts to sites valued for historic and cultural significance.

Chapter 7 Summary and Next Steps

This section provides a brief summary and provides the next steps for the CALFED Bay-Delta Program (CALFED) (See Box 7-1 for a list of acronyms and abbreviations used in this section) surface storage investigations related to the feasibility studies, National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) environmental documentation, and 2009 Comprehensive Water Package.

Summary

California's water resources future has become increasingly uncertain and water management challenges are great. California is faced with:

- Declining ecosystems within the Sacramento-San Joaquin Delta (Delta) and Sacramento and San Joaquin river basins
- Greater impacts of droughts and decreased water supply reliability
- Impaired water bodies due to poor water quality
- Climate change
- Increasing flood risk
- Uncertainties of future Delta water management

Consequently, potential new surface storage projects will need to perform well under a number of potential future conditions, including potential new Delta conveyance. Surface storage must also support restoration actions with adaptive management. It must also provide flexibility to statewide and regional water management systems under various future scenarios to help ensure that the projects remain good investments. For example, Chapter 2 discussed how climate change introduces further uncertainty and risk in the availability of water supplies for California. This creates a significant challenge for hydrologic modelers to predict water supply availability into the future. Various climate change scenarios will be reviewed and considered for analyzing project performance for each of the surface storage investigations for the draft Feasibility Reports and Environmental Impact Statements/Environmental Impact Reports (EIS/EIR). Additionally, each investigation will consider the impacts of various future projects and programs, such as modified or new conveyance in the Delta, on potential surface storage project performance in the draft Feasibility Reports and EIS/EIRs.

Each project section discussed preliminary modeling conducted for this Progress Report on how example surface storage project formulations could be coordinated with potential new Delta conveyance. With new Delta conveyance, project objectives and operations of the potential surface storage projects would be adjusted. For example, potential surface storage projects may not be operated to improve Delta water quality for exported water because it is assumed that new Delta conveyance operations would provide substantial water quality benefits. For the most part, the surface storage projects could provide the same types of benefits described in the previous sections, but to varying degrees with or without new Delta conveyance. Typically, new Delta conveyance enhances project water supply benefits due to the increased ability to move water supply through the Delta, resulting in improved flexibility for exchange operations with the CVP and SWP systems. Figure 7-1 illustrates the potential combined water supply yield from all four CALFED surface storage projects operated with and without an assumed new Delta conveyance.

Box 7-1. Chapter 7 Acronym and Abbreviation List

BDCP	Bay-Delta Conservation Plan
CALFED	CALFED Bay-Delta Program
CEQA	California Environmental Quality Act
Delta	Sacramento-San Joaquin Delta
DHCCP	Delta Habitat Conservation and Conveyance Program
DWR	Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
NEPA	National Environmental Policy Act
Reclamation	United States Bureau of Reclamation

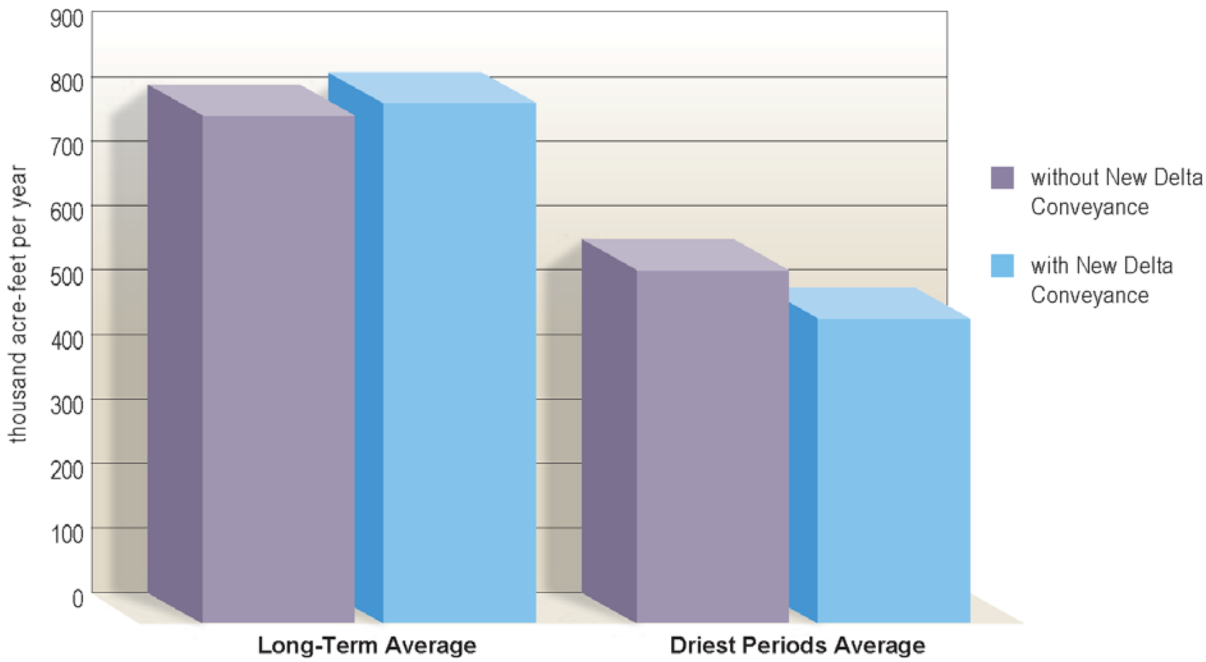

Figure 7-1. Potential Long-Term Average and Driest Periods Average Water Supply Yield from the CALFED Surface Storage Projects when Operated with and without Assumed New Delta Conveyance

As a result of water management challenges and uncertainties, water resources planning has changed significantly over the past several decades. New planning approaches to CALFED surface storage has resulted in a new era of project formulations. Project formulations have been explicitly conceived to support multiple CALFED program objectives such as water supply reliability, water quality, and ecosystem restoration. From the beginning of CALFED surface storage planning, it was acknowledged that the dam building model of the past would not be the primary solution for solving California's water challenges. Instead, project formulations would emphasize effective mitigation of potential impacts and improve environmental conditions. Project purposes emphasized storage that combined ecosystem restoration and water quality with more traditional purposes of water supply reliability, hydropower, and flood control. For example, these new projects would support aquatic and riparian ecosystem restoration focused on the Delta and its tributaries; improved drinking and habitat water quality; and water supply reliability improvements that ultimately support California's growing population and diverse economy (DWR, 2009a).

The CALFED surface storage project formulations have dedicated significant project resources (as primary and secondary objectives) to public benefits, including ecosystem restoration, water quality, flood control, emergency response, and recreation. Public benefits would be paid for by the state and/or federal governments. Potential projects also contribute to a reliable water supply for California. Urban and agricultural water supply reliability and drinking water quality are generally considered non-public benefits paid by water retailers and users.

The size and location of these surface storage projects facilitates the accomplishment of benefits in distinct ways:

1. Many benefits are achieved directly by releases from a new reservoir. For example, flows released from new storage facilities can provide targeted water to mimic the natural environment for ecosystem needs, help restore aquatic and riparian habitat, provide flushing flows for pollution from point and non-point sources, and provide better water quality.

2. Additional storage can provide significant system flexibility such that other facilities' operations can be modified (without reducing current benefits) to support additional benefits within the system. Additional water in storage can be used to either improve ecosystem functions and conditions for targeted species, or improve water quality or supply reliability for water users (DWR 2009a).

Implementation of new CALFED surface storage would potentially affect environmental and human conditions. There are some potential positive and negative effects. Regulatory and permitting requirements will require surface storage investigations to consider potential effects to stream flow regimes, water quality, stream geomorphology, fish and wildlife habitat, and risk of dam failure during seismic and operational events. In addition, agencies are developing analytical methodologies to determine greenhouse gas emissions associated with project construction and operations and their contribution to climate change. Mitigation of significant effects is required under state and federal environmental laws and is accomplished through implementation strategies that avoid, minimize, reduce over time, or mitigate for negative effects. Input from tribes, the public, and agencies has already been received by the Department of Water Resources (DWR) and the Bureau of Reclamation (Reclamation) on potential negative effects associated with project implementation. Additional input is anticipated as feasibility studies continue and NEPA/CEQA alternatives are developed and evaluated during the final phases of the investigations.

Next Steps

Since the release of many of the CALFED surface storage project documents (e.g., Initial Alternatives Information Reports and Plan Formulation Reports), the planning, biological, and regulatory environments have changed. These new conditions include Biological Opinions and reasonable and prudent alternatives for delta smelt and salmon, pumping constraints, the 2009 Comprehensive Water Package, Bay-Delta Conservation Plan (BDCP)/Delta Habitat Conservation and Conveyance Program (DHCCP) planning and decisions, climate change impacts and adaptation strategies, and rising sea levels. Solutions to Delta ecosystem restoration and improved water conveyance needs may result in changes to the pattern and timing of Delta water diversions, affecting water quality and hydrodynamic conditions in the Delta. These changes will help inform existing and future conditions for analysis in the feasibility reports and environmental documentation for the investigations. The draft Feasibility Reports and EIS/EIRs for the surface storage investigations are scheduled for release in 2011. Major future actions required to complete the investigations include:

- Evaluate project alternatives to reflect potential changes to existing and future conditions in the Sacramento and San Joaquin River Basins and the Delta, resulting from the ongoing operations reconsultation, BDCP/DHCCP efforts, and climate change
- Complete environmental studies, evaluations, and documentation to determine the type and extent of potential environmental impacts per NEPA and CEQA
- Identify potential effects (adverse and beneficial) and mitigation measures of the alternatives
- Develop detailed designs and cost estimates, potential benefits, cost allocation, and rationale for the selection of a Recommended Plan
- Conduct public outreach meetings and workshops with stakeholders, including federal and state agencies, tribes, and with Central Valley Project and State Water Project contractors
- Identify non-federal cost share partners
- Determine financial feasibility through ability-to-pay analyses of federal and non-federal project partners
- Prepare federal decision documents

An approximate schedule for the remaining feasibility studies is provided on Figure 7-2.

Senate Bill 2 and Funding to Develop Storage

If approved by California voters, Senate Bill 2 would authorize the issuance of an $11.14 billion bond to finance a safe drinking water and water supply reliability program (See Figure 7-3). Three billion dollars in funding would be made available for storage projects, and those projects approved for funding would be determined by the California Water Commission. Storage projects eligible for funding include the storage projects identified in the CALFED Record of Decision (CALFED, 2000b); groundwater storage and groundwater remediation projects that provide storage benefits; conjunctive use and reservoir reoperation projects; and local and regional storage projects that improve the operation of water systems and provide public benefits.

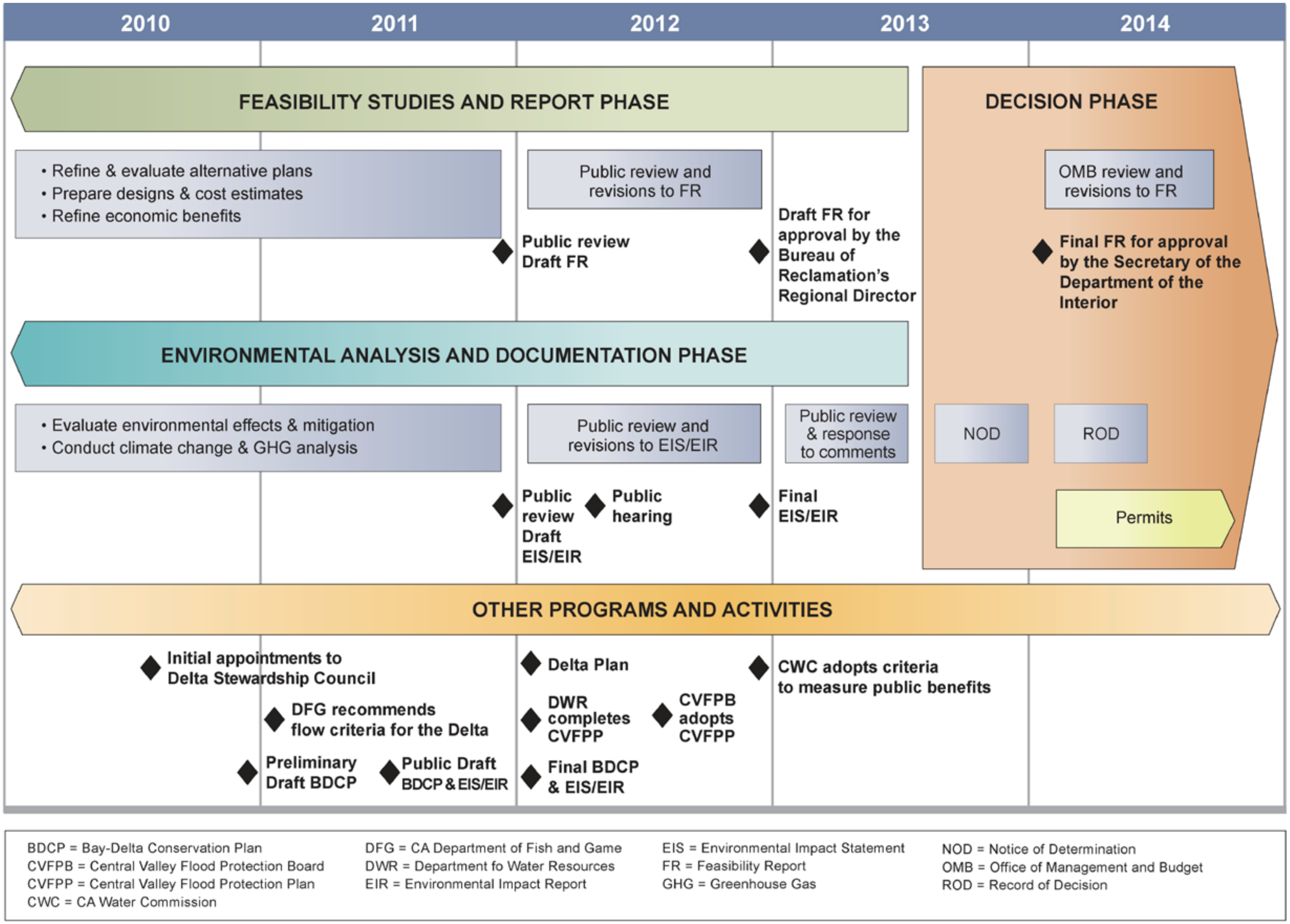

Figure 7-2. Approximate Schedule for the Surface Storage Feasibility Studies (Dates are estimated to adequately represent all of the studies)

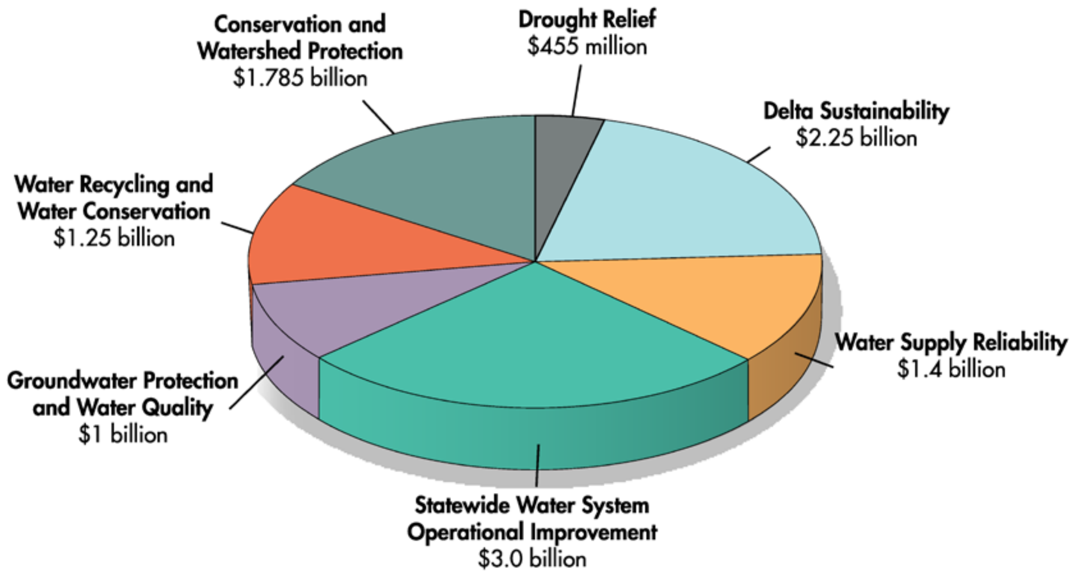

Figure 7-3. Bond Fund Breakdown

Money from the bond can only fund a maximum of 50% of the total project costs and can only be used to fund environmental enhancements or other public benefits, which are defined as:

- Ecosystem improvements, including changing the timing of water diversions, improvement in flow conditions, temperature, or other benefits that contribute to restoration of aquatic ecosystems for native fish and wildlife, including ecosystems and fish and wildlife in the Delta
- Water quality improvements in the Delta, or in other river systems, that provide significant public trust resources, or that clean up and restore groundwater resources
- Flood control benefits, including, but not limited to, increases in flood reservation space in existing reservoirs by exchange for existing or increased water storage capacity in response to the effects of changing hydrology and decreasing snow pack on California's water and flood management system
- Emergency response, including, but not limited to, securing emergency water supplies and flows for dilution and salinity repulsion following a natural disaster or act of terrorism
- Recreational purposes, including, but not limited to, those recreational pursuits generally associated with the outdoors

Funds cannot be expended to pay for costs associated with environmental mitigation measures or compliance obligations. Additionally, ecosystem improvements must account for 50% of the public benefits funded.

Projects will be selected by the California Water Commission through a competitive public process ranking the potential projects based on the expected return for public investment based on the amount of public benefits provided. For storage projects to be approved for funding, methods for reviewing projects need to be determined and a comprehensive review process needs to be completed, including:

1. California Water Commission must adopt methods for measuring environmental benefits (methods must be adopted by December 15, 2012)
    a. Using these methods, public benefits will be quantified for each eligible storage project
2. DWR must contract with each project beneficiary not receiving public benefits for its share of the project cost (DWR must receive commitments for 75% of the nonpublic benefit cost share of the project)
3. DWR must contract with the California Department of Fish and Game, State Water Resources Control Board, and other public agencies as necessary to ensure public benefits are administered and achieved
4. California Water Commission must conduct a public hearing process for public review and comment
5. Additional conditions that must be met:
    a. Project feasibility studies are complete
    b. California Water Commission determines that the project is feasible and will advance the long-term objectives of restoring ecological health and improving water management for beneficial uses of the Delta
    c. All project environmental documentation is complete and required federal, state, and local approvals have been obtained

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Appendix A. 2009 Comprehensive Water Package

In 2009, Governor Arnold Schwarzenegger and state lawmakers successfully crafted a plan to meet California's growing water challenges. A comprehensive deal was agreed to, representing major steps towards ensuring a reliable water supply for future generations, as well as restoring the Sacramento-San Joaquin Delta (Delta) and other ecologically sensitive areas. The plan was comprised of four policy bills (Senate Bills [SB] 1, 6, 7, and 8) and an $11.14 billion bond (SB 2). The package established the Delta Stewardship Council, set ambitious water conservation policy, ensured better groundwater monitoring, and provided funds for the State Water Resources Control Board (SWRCB) for increased enforcement of illegal water diversions. The bond would fund, with local cost-sharing, drought relief, water supply reliability, Delta sustainability, statewide water system operational improvements, conservation and watershed protection, groundwater protection, and water recycling and water conservation programs.

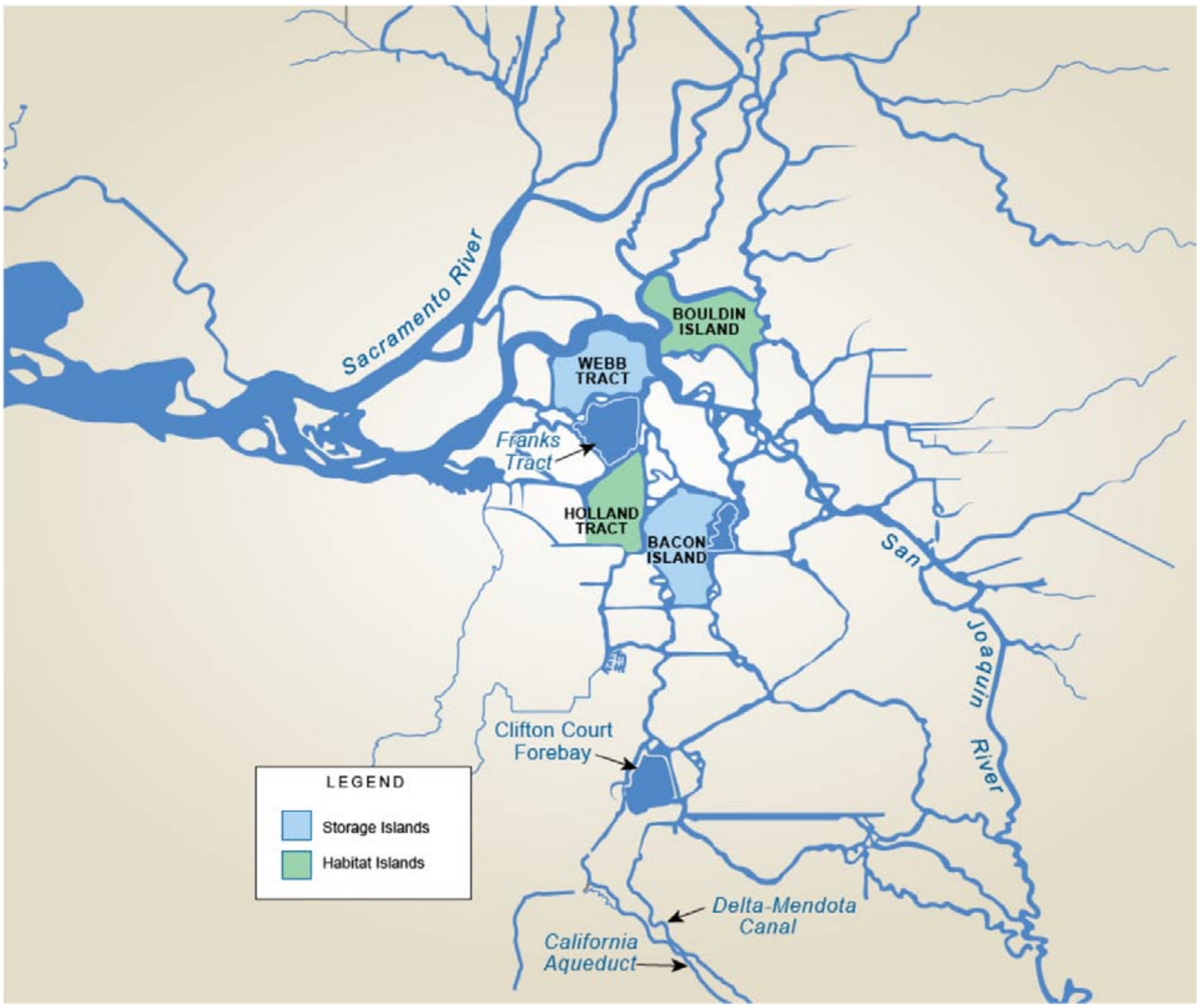
Per the comprehensive water package, a new era of planning and coordination for the Delta was established. The new Delta Stewardship Council is tasked with developing a Delta Plan that furthers the Delta Vision's co-equal goals of Delta restoration and water supply, while the new Sacramento-San Joaquin Delta Conservancy will implement ecosystem restoration activities in the Delta and the Bay-Delta Conservation Plan will further evaluate different conveyance configurations in the Delta. The SWRCB will develop flow criteria for the Delta to be used for planning purposes, and set the framework for stronger accounting of water diversions from the Delta.

Funding for the measures included in the 2009 Comprehensive Water Package depends on public approval of an $11.14 billion bond. The bond funds would make $3 billion available to fund the public benefits associated with water storage projects that improve the operation of the state water system, are cost-effective, and provide a net improvement in ecosystem and water quality conditions. Public benefits were categorized in the legislation as ecosystem improvements, water quality improvements, flood control benefits, emergency response, and recreational purposes. Ecosystem benefits must account for 50% of the total public benefit funded per project. These funds would be awarded through a competitive process. Eligible projects would include:

- CALFED Bay-Delta Program surface storage projects
- Groundwater storage projects and groundwater contamination prevention and remediation projects that provide water storage benefits
- Conjunctive use and reservoir reoperation projects
- Local and regional surface storage projects that improve the operation of state water systems and provide public benefits

Appendix B. Summary of the In-Delta Storage Program

In-Delta Storage was one of the five surface storage investigations identified for further review and study in the CALFED Bay-Delta Program (CALFED) Record of Decision (ROD). The proposed In-Delta Storage Project would provide capacity to store approximately 217,000 acre-feet of water in the south Sacramento-San Joaquin Delta (Delta) for a wide array of water supply, water quality, and ecosystem benefits. The proposed project (See figure) would include two storage/reservoir islands (Webb Tract and Bacon Island) and two habitat islands (Holland Tract and Bouldin Island), similar to a project proposed by Delta Wetlands Properties (Delta Wetlands) over a decade before the CALFED ROD.



Location of the In-Delta Storage Project Reservoir and Habitat Islands

In 2001, the Department of Water Resources (DWR) and the California Bay-Delta Authority, with technical assistance from the Bureau of Reclamation (Reclamation), began evaluating the Delta Wetlands Project and in-Delta storage options; this evaluation was completed in May 2002. In June 2002, based on the initial work completed by DWR and Reclamation, the Bay-Delta Public Advisory Committee recommended that the CALFED implementing agencies complete additional evaluations and address several issues before considering implementation of the In-Delta Storage Project. The 2004 Draft State Feasibility Study reports the findings of this additional work.[1]

A Supplemental Report to the 2004 Draft State Feasibility Study[2] was prepared in response to comments received during the public review of the 2004 Draft State Feasibility Study report. However, conditions in the Delta and knowledge of these conditions had significantly changed between the preparation of the 2004 and 2006 reports. These changing conditions included a decline in the abundance of pelagic organisms and increased knowledge and concern over seismic instability and global climate change and their respective effects in the Delta. There was increasing awareness that the Delta was fragile and the current configuration of the Delta would become more difficult to maintain—operational decisions were changing flows through the Delta, a major earthquake could cause catastrophic levee failures and disrupt the state's water supply system, and the Delta would have to withstand increased sea level and larger floods in the face of a changing climate.

The Delta, and people's perception of it, was rapidly changing. Many efforts were under way to improve our understanding of the Delta, including studies into pelagic organism decline, the Delta Risk Management Strategy, Delta Vision, and others. In 2006, DWR deferred the decision to proceed with the study of In-Delta storage until such a time that the Delta efforts were completed or Delta uncertainties were better understood. Funding for DWR's participation in the In-Delta Storage Program has been suspended since 2006. However, Delta Wetlands has continued to investigate In-Delta storage. Delta Wetlands and Semitropic Water Storage District, a new implementing agency and lead agency for California Environmental Quality Act compliance, released a draft Environmental Impact Report in May 2010 for a revised formulation of In-Delta storage.

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[1] DWR, 2004. *In-Delta Storage Program State Feasibility Study*. Draft. January.

[2] DWR, 2006. *Draft Supplemental Report to 2004 Draft State Feasibility Study. In-Delta Storage Project.* January.

Appendix C. California Water Plan – Integrated Water Management Framework

The California Water Plan Update 2009 provides direction for surface storage planning. A primary theme of the California Water Plan is that California's policies, decisions, and actions must lead to long-term, sustainable water resource use that enhances the environment, economy, and our communities. In order to fulfill this vision, water policies, decisions, and actions must ensure sustainable water uses and reliable water supplies. Based on these two premises, the California Water Plan identifies foundational actions (use water efficiently, protect water quality, and expand environmental stewardship) and initiatives (expand integrated regional water management and improve statewide water and flood management systems) for integrated water management.

Vision of Integrated Water Management from CA Water Plan

The CALFED surface storage investigations are included under the "Initiatives for Reliable Water Supplies – Improve Statewide Water Management Systems" (See figure) since the investigations seek to integrate potential solutions with the Central Valley Project and State Water Project. The other initiative, implementation of integrated regional water management, is essential to California's water resources future; the surface storage investigations are integrated with local and regional planning efforts. Increasing integration with local and regional water resources planning will continue as draft environmental and feasibility documents are prepared. The investigations' primary purposes of ecosystem restoration, water quality, and improved regional and local supplies are consistent with the

California Water Plan's directives and need to be integrated with local and regional planning efforts.[3]

At the beginning of the California Water Plan Update 2009, the Department of Water Resource's former Director, Lester Snow (currently the Secretary of the Natural Resources Agency), stresses the importance of both statewide and regional integrated water management planning and investments. Successful statewide water management planning will require integration with numerous regional water management efforts. In addition, statewide integrated planning, such as the surface storage investigations, are being integrated with other statewide water management efforts such as Bay-Delta Conservation Plan, Delta Habitat Conservation and Conveyance Program, and the Delta Plan.

The Water Plan also emphasizes the importance of sustainable management of our water resources that provides for our ecosystems, the economy, and equity.[4] The surface storage investigations are formulated to explicitly improve both ecosystems and water supply reliability. Equity is incorporated through a number of state and federal planning requirements including environmental justice, the California Environmental Quality Act, and the National Environmental Policy Act.

Finally, the Water Plan also describes the relationship between integrated regional water management and statewide integrated water management. Recommendation 4 says, "State government should effectively lead, assist, and oversee California's water resources and flood planning and management activities that regions cannot accomplish on their own." This recommendation recognizes that regional water planning efforts cannot, on their own, solve all of California's water management problems. More specifically, challenges that are directly associated with the state and federal water projects should be led and assisted by the state and federal governments, with integrated leadership from regional and local interests.

[3] DWR, 2009. *Update 2009 California Water Plan. Integrated Water Management.* Pre-Final Draft. October 16.

[4] DWR, 2009

Appendix D. Delta Planning Efforts

Various state and federal planning efforts are working toward developing a long-term plan for a sustainable Sacramento-San Joaquin Delta (Delta) including Delta Vision, Bay Delta Conservation Plan and Delta Habitat Conservation and Conveyance Program (BDCP/DHCCP), and the Delta Plan.

Delta-Vision

The Delta Vision Blue Ribbon Task Force was established by Governor Arnold Schwarzenegger in 2006 to "develop a durable vision for sustainable management of the Delta." The Task Force completed their Vision in December 2007 and Strategic Plan in October 2008. A key recommendation of the Delta Vision was the consideration of the Delta ecosystem and a reliable water supply for California as primary, co-equal goals. The Task Force recognized that current use of the Delta and its resources is unsustainable and major changes in the Delta and in California's use of Delta resources is inevitable. The Task Force also recommended:[5]

> *"New facilities for conveyance and storage, and a better linkage between the two, are needed to better manage California's water resources for both the estuary and exports."*

To advance this recommendation, the Task Force identified the goal—to build facilities to improve the existing water conveyance system and expand statewide storage, and operate both to achieve the co-equal goals—in its Strategic Plan.[6]

BDCP/DHCCP

The BDCP is a federal and state planning and environmental permitting process to restore and preserve habitat for endangered and threatened Delta fisheries and provide for reliable water supplies. The DHCCP is a program overseeing the development of preliminary engineering and environmental documentation for implementing conveyance and ecosystem restoration actions considered in the BDCP.

The BDCP is considering a range of alternatives that would combine a Delta conveyance option with compatible restoration opportunities, actions to address other stressors, and corresponding adaptive management strategies. Considered conveyance options include existing through-Delta conveyance, improved through-Delta conveyance, dual conveyance, and a peripheral aqueduct or tunnel. Each conveyance option would likely result in different water quality and hydrodynamic conditions in the Delta and different resulting opportunities for habitat restoration. The BDCP would also include adaptive management and monitoring programs to address uncertainties regarding the role and importance of various stressors on the Delta ecosystem.

[5] Delta Vision, 2007. *Our Vision for the California Delta*. Delta Vision Blue Ribbon Task Force. December.
[6] Delta Vision, 2008. *Delta Vision Strategic Plan*. Delta Vision Blue Ribbon Task Force. October.

Senate Bill 1 and the Delta Plan

As part of the 2009 Comprehensive Water Package, Senate Bill (SB) 1 established the Delta Stewardship Council, which would act as an independent agency of the state. The Delta Stewardship Council is tasked with developing the Delta Plan, a comprehensive management plan for the Delta, by January 1, 2012.

The new Delta Plan will include requirements for flow criteria, diversion rates, and other operational criteria for informational planning decisions. The flow criteria will be developed by the State Water Resources Control Board with assistance from the state and federal fish and game agencies. The new flow criteria's objectives are to improve the health of Delta species (aquatic and terrestrial) with public involvement and will include existing water quality objectives and the best available scientific information, including the volume, quality, and timing of water necessary for the Delta ecosystem under various conditions.

Additionally, SB 1 established the Sacramento-San Joaquin Delta Conservancy under the Natural Resources Agency, who would act as the primary state agency to implement ecosystem restoration in the Delta and to support efforts that advance environmental protection and the economic well-being of Delta residents. The Delta Conservancy is tasked with developing a strategic plan for accomplishing the above tasks.

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